MONTHLY NOTICES

OF THE

ROYAL ASTRONOMICAL SOCIETY.

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E. J. STONE, Esq., M.A., F.R.S., President, in the Chair.

Franklen George Evans, Esq., Tynant House, near Cardiff, was balloted for and duly elected a Fellow of the Society.

The Meridian Photometer. By Professor Edward C. Pickering.

This instrument is designed for the photometric observation, on or near the meridian, of objects not fainter than stars of the tenth magnitude. A smaller instrument constructed upon the same general principles has been used during the past three years in comparing the brightness of all stars visible in this latitude to the naked eye. This work is now nearly completed. The new instrument will be largely used in determining the ratios of light corresponding to the scale of magnitudes employed in the construction, and in the recent revision, of the "Bonner Durchmusterung." For this purpose, measurements will be made of the light of the stars observed during this revision at each of two co-operating Observatories. These stars are situated near the borders of the zones into which the northern heavens were divided in order to distribute the work of determining the positions of the stars.

One of the annexed photographs * exhibits the whole of the new instrument; while the other represents, on a larger scale, the end of it farthest from the eyepiece. The two plane mirrors at this end of the photometer are connected with tubes placed horizontally east and west, and capable of revolution in the

* The photographs are in the library of the Society.

plane of the meridian. The inclination of each mirror to the axis of its tube may also be varied. By means of connecting-rods and cords these movements of both kinds may be effected by the observer without leaving his place at the eyepiece, and also by an assistant stationed near the mirrors. One of the mirrors is ordinarily directed to λ *Ursæ Minoris*, with which the other stars are compared. The second mirror is connected with a longer tube, and projects beyond the first, so that it may be directed to any star within a few minutes of its meridian passage.

The light from the two mirrors is received respectively by two object-glasses of about four inches aperture and sixty inches focal length, placed within the instrument, and not shown in the photographs. Both the pencils of rays, before reaching the eyepiece, pass through a double-image prism, which can be reversed by the observer, in order to eliminate the error due to the partial polarisation of the light from the mirrors. The ordinary image received from one mirror and object-glass is compared with the extraordinary image from the other mirror and object-glass by means of a Nicol connected with the eyepiece. The double-image prism is then reversed, and the comparison repeated with the other pair of images, which are thus brought nearly to the place in the field previously occupied by the first pair. The pair not in use at the time is excluded from the field by an eye-stop.

A curtain, not shown in the photographs, protects the observer from the light of the gas-burners which illuminate the circles of the instrument. The assistant directs the mirror to the successive stars to be observed, and records the readings of the photometer circle near the eyepiece.

The two images compared in an observation with this instrument are placed under the same conditions, and it may therefore be hoped that the results obtained will be free from systematic error. Among causes likely to produce such error in photometric observations may be named those stated in the list below. Care has been taken to guard against them either in the construction of the instrument or in the methods of observation and of reduction which have been adopted.

1. Variation in light of the star or other object used as the standard of comparison.

2. Difference in the background of the respective images, due to twilight, moonlight, or other causes.

3. Varying atmospheric absorption, when the same object is observed at different altitudes.

4. Difference in reflecting-power of two mirrors.

5. Partial polarisation produced by reflection from mirrors.

6. Difference in the appearance of the images, due to unequal magnifying power, or to unlike sources of light.

7. Difference in the size or position of the two pencils of rays forming the images.

8. Difference in the relative positions in the field of the two images in different observations.

Harvard College Observatory:
1882, *May* 8.

On Photographs of the Nebula in Orion, and of its Spectrum.

By Henry Draper, Esq., M.D.

(*Communicated by A. C. Ranyard, Esq.*)

At the meeting of the Royal Astronomical Society in January 1881 I presented a photograph of the nebula in *Orion*, which was taken on September 30, 1880, with my Clark telescope of 11 inches aperture and an exposure of 51 minutes. This was the first photograph ever taken of a nebula. It comprised the brightest parts in the neighbourhood of the trapezium, and showed the condensed masses well. In March 1881 a number of photographs of the nebula were taken, the best being on March 11 with an exposure of 104 minutes. By comparison with the former picture this made a marked advance, and minute stars down to the 14·7 magnitude of Pogson's scale were shown. An account of it was read before the French Academy of Sciences, and printed in the "Comptes Rendus," April 18, 1881.

On March 14, 1882, the negative was made from which the enlarged photolithographs herewith presented were produced. The instrument used was the Clark photographic refractor of 11 inches aperture, mounted on the equatoreal stand, and driven by the clock I had constructed. The exposure was from $7^h\ 8^m$ to $9^h\ 25^m$—that is, 137 minutes. Gelatino-bromide plates were employed. The night was clear, but cold and windy. The mean temperature was 27° F.; the wind NNW. and in gusts, the strongest pressure being 5 pounds per square foot, about 9 o'clock; the whole travel of the wind during the exposure was 35 miles. The variation in the force of the wind is one reason why the stars show some ellipticity under this magnifying power. The gusts of course displaced the telescope somewhat, though the mounting is firm and the clockwork strong.

In the photograph the larger stars are much over-exposed, the proper time to make a good picture of the trapezium being about 2 minutes. The twinkling of these stars is therefore recorded on the sensitive plate, and gives to them an excess of size. If a photograph should be taken on a steady night, the stars of the trapezium would be easily separated, and in the original negative of this picture, in a strong light, the separation can be seen. The variation in size of the stellar images gives an idea of the relative magnitude of the stars, though that estimate requires correction for the colour of the stars. It must be remembered that no one enlargement can do justice to the original negative: various exposures, various intensities of light,

and various points of view are necessary for a complete examination.

On comparing this photograph with the well-known drawings of the same object by Lord Rosse, Bond, Struve, Lassell, Trouvelot, Secchi, and others, it will be noticed that most of the small stars, about which there is no dispute, are represented, and the outlying streamers are well indicated. It is worthy of remark also that in this photograph with an exposure of only 137 minutes I have depicted stars almost the *minimum visible* in this telescope, and it is not unreasonable to hope that by still further prolonging the exposure and by still further study of photographic processes, stars and details entirely invisible to the eye may be secured. With this object in view, I have under consideration a new form of mounting which will permit of continuous exposures of six hours.

During the month of March 1882 I also made four photographs of the spectrum of the nebula in *Orion*, which are described in the May number of the "American Journal of Science." Two of these were obtained with the slit spectroscope I usually employ for photographing spectra of the stars, and they show two lines in the ultra-violet plainly, besides the traces of two others. The first-mentioned two are hydrogen γ λ 4340 and hydrogen δ λ 4101; the others are too faint to give a good estimate of the wave-length.

The other spectrum photographs, taken without a slit, show that two of the condensed masses preceding the trapezium give a continuous spectrum, and therefore contain either gas under pressure, or liquid or solid matter.

271 *Madison Avenue, New York:*
1882, *May.*

Some Remarks on Mr. Newcomb's Paper "On the Instructions for Observing the Transit of Venus formulated by the Paris International Conference." By E. J. Stone, Esq., M.A., F.R.S.

It is greatly to be regretted that the step which was taken by the English Committee in the October of 1881 of issuing a draft of Instructions to Observers for consideration and discussion did not lead to any direct interchange of ideas between the American and European astronomers. I believe that an interchange of ideas, such as that contemplated, would have led to the adoption of "Instructions" which were identical in all essential points, and I hope that this object may yet be secured. The remarks made in the *Notices* for April by Mr. Newcomb, on the Instructions issued by the International Committee on the Transit of *Venus*, are interesting, and require consideration; but unfortunately they are stated to be simply "an individual contribution to the discussion," and the time for discussion is

fast passing away and that for action is approaching. It appears to me, however, that there are really but few important points upon which Mr. Newcomb's views differ essentially from those which were attempted to be embodied in the International Instructions, and that something like common action is still possible. All astronomers have their favourite way of describing the "real contact," but mutual concessions on unimportant points are necessary if combined action is desired. I have, in this note, thrown together a few remarks which have occurred to me whilst reading Mr. Newcomb's paper. I hope these remarks will, at least, be considered before any Instructions are issued to the American observers which may prevent their observations of contacts from being ultimately combined in one general discussion with those observed by the French, German, and English observers. A chain is not stronger than its weakest link, and the value of the large number of observations of contact at "Ingress retarded" and "Egress accelerated," which will undoubtedly be secured, if the weather is favourable, by the American observers, will depend very much indeed upon the number of contacts of "Ingress accelerated" and "Egress retarded" which may be available for direct comparison with them, and for most of these the American astronomers will be dependent upon the observers of other nations.

The most important point upon which Mr. Newcomb's views appear to differ from mine is the question of the brightness of the field of view in which the contacts should be observed. Mr. Newcomb considers "that the observer should have the solar disk as bright as the eye could bear with entire ease and comfort." I cannot think this desirable. If the sky was covered with thin cloud or haze at one of the stations, the difference would be excessive between the brightness of the field available at that station and the brightness which would be adopted at stations where the sky was perfectly clear. There are also very considerable differences in the degree of illumination of the field of view which different observers can bear with ease and comfort, and all the phenomena of irradiation are presented in an aggravated form when the brightness of the field is excessive. The complications introduced by the phenomena of irradiation are perhaps the difficulties chiefly to be feared in attempts to determine the value of the solar parallax from a discussion of internal contacts. I think, therefore, that we are not justified in adopting a brightness of the field of view which must increase to the utmost these difficulties.

But the changes in the illumination of the Sun's limb, which take place near the point of contact, can only be recognised by contrast; it is therefore essential that the brightness of the field should be sufficient to allow these differences of illumination to be readily distinguished, and the adoption of a field of view with a very feeble illumination is not, therefore, desirable. It will be found, on consideration, that difficulties quite as great as those

dependent on the irradiation phenomena can be introduced by unduly diminishing the brightness of the field. Pairs of very fine spider webs at distances corresponding to a second of arc in the focus of a positive eyepiece appear to afford a delicate test of a suitable field. But this test requires great care in its application, and I am inclined to think that a rougher but better practical test is afforded as follows:—

Let an observer mark the part of his wedge where he can just observe the Sun's limb in a perfectly clear sky without discomfort. This degree of brightness is, I consider, excessive. Let him also mark the part of the wedge at which, under the same circumstances, he could just distinctly and clearly observe the Sun's limb. This field is the faintest which that observer could adopt, and is, in my opinion, decidedly *too* faint. If the observer adopts the mean portion of the wedge as giving, under a clear sky, a standard brightness of the field of view, he cannot err much either in excess or defect. There will of course be slight differences of opinion amongst observers of what constitutes the *best* degree of illumination of the field, but all the skilled observers who have examined the point at Oxford agree that the field of view thus found is an agreeable one to observe in, and that the brightness is sufficient to allow the rice-grains and the minute details of solar spots to be well seen. Slight changes in the portion of the wedge recommended for use are unimportant, but it is desirable that excessive differences in the brightness should be avoided, and that some approximation to uniformity in this respect should be secured. The brightness of the field fixed as described, on a clear day, would have to be learnt by practice as a habit of the eye, and adopted, as closely as possible, by shifting the wedge to meet the varying conditions of the atmosphere at the time of observation. This is the recommendation which I should make with regard to the brightness of the field of view in which the contact should be observed. It secures approximate uniformity, and it excludes extremes of either excessive brightness or undue faintness in the illumination of the field of view.

I could not join in Mr. Newcomb's recommendation of the use of Dawes' solar eyepiece. This eyepiece is valuable for the examination of detached portions of the solar disk; but the field of view is exceedingly limited, and when clouds were passing there would be practical difficulties in keeping the point of contact exactly in the centre of the field, whilst the effects of the stop, near the edge of the field, would be most injurious in the contact observations.

I must confess that I cannot understand the difficulties which Mr. Newcomb experiences in forming a precise conception of what should be understood by the phrase "illumination of the apparent limb of the Sun" and "how discontinuity in that illumination should be noted." The "illumination of the *apparent* limb of the Sun" means the illumination of the limb of the Sun

as seen—the visible limb; and the discontinuity of the illumination can be noted as follows:—Suppose *a*, *c*, *b* to be three small portions of the visible, or apparent, limb of the Sun, *c* being the portion near which the internal contact takes place. Before contact at Egress, or after contact at Ingress, there will be no sensible difference between the illumination of the portions *a*, *c*, *b*, but near the contact the illumination of the Sun's limb at *c* will be less than the illumination either at *a* or *b*. This difference between the illumination at *c* and at *a* and *b* constitutes a discontinuity in the illumination of the Sun's limb near the point of contact, which every observer must see, if the sky is clear, near the internal contacts. The observers are therefore simply asked to give at Ingress the last time at which they are *certain* of the existence of such a discontinuity as independent of mere atmospheric tremor; and at Egress, the first time at which they are certain of such a discontinuity. In the English Instructions the observers will be asked to give also the times of deepest shade, when the black drop, ligament, haze, or shadow ceases to be as dark as the outer edge of the planet *Venus* at Ingress, or first becomes as dark as the outer edge of that planet at Egress. I hope and believe that the observers will experience no difficulty in understanding these instructions, and that they will observe the contacts as defined.

The contacts as defined in the International Instructions are the same as those which Mr. Newcomb would, *apparently*, wish to have observed. I say *apparently*, for in many parts of Mr. Newcomb's paper it would appear that he prefers to leave the observer without any precise definition of the contacts to which his attention should be directed—a course of proceeding which, in my opinion, could lead to nothing but a complete failure: but if Mr. Newcomb simply recommends the observers to give at Ingress "the time when light is about to glimmer all the way across the dark space between cusps," the recommendation would do no harm. The time which should then be given by the observers would be the time when there was last seen a distinct and persistent discontinuity in the illumination of the Sun's limb at the point of contact. The chief difference between the definitions appears to be that Mr. Newcomb prefers to direct the attention of the observer to the light of the cusps which is encroaching upon the "*dark space*" between them, whilst in the definition adopted by the International Conference the attention of the observer is directed to the disappearance of the *dark space* between the cusps.

But if Mr. Newcomb's definition were adopted it would be necessary to introduce an exception, and to caution the observers from taking the time when the light of the aureole, penumbra, or "sunlight through the atmosphere of *Venus*" began to glimmer across the dark space between the cusps. Without this caution the observed contacts would be very uncertain and the times recorded would be earlier at Ingress than those which Mr. New-

comb requires by about a minute of time. Mr. Newcomb's definition and that of which it is a modification and improvement, given in the *Notices* for March 1877—viz. "the time at which true sunlight is first seen all the way around the following limb of the planet"—is open to the objection that it is of a negative character. The first time at which bright sunlight is seen may be caught up, through clouds, long after all touch between the limbs has ceased. Such observations when recorded as contacts destroy the value of a large number of good observations, unless rejected, and this is always an unsatisfactory proceeding, and one sometimes open to misconceptions. If properly understood and strictly followed, the definition of Mr. Newcomb should lead to identical results with that adopted at the Paris Conference; but I cannot regard it as an improvement. To the recommendations to leave each observer from a knowledge of the general theory of the subject to observe any contact which he considers best under existing conditions, and to the proposals of IV., page 280, I object *in toto*.

I have no wish to indulge in mere verbal criticisms, but it is desirable to point out that Mr. Newcomb's views of the nature of the internal contacts have been very much based on model-practice, and that, without great care, this model-practice is misleading. In the case of the model we have the Sun's limb represented by one hard edge and the planet represented by a disk. There are therefore complicated phenomena of diffraction beyond the hard edge which represents the Sun's limb, and of interference between the limbs of *Venus* and the Sun, which vary as the contact approaches, and which have nothing strictly analogous to them in the case of the actual transit; whilst, on the other hand, the light which is refracted through the atmosphere of *Venus* in the real transit introduces complications to which there is nothing strictly analogous in the models in general use. Whilst therefore model-practice may be useful to observers, in preparing them for the slowness with which the contacts are established and in exhibiting changes somewhat similar in general character to those which will be presented in the real transits, the observers require to be carefully cautioned against expecting to see the *same* succession of phases identically reproduced in their model-practice and in the real transit. And here I must point out that when Mr. Newcomb speaks of the "true internal contact" and of the "sharp cusps of *Venus*, instead of appearing sharp as in *their true form*, appear rounded at their termini by the black drop or other forms of distortion," the language used is misleading. There is no "true internal contact," neither are there cusps, except as we see them projected on the Sun's disk; and the phenomena as seen are the *real phenomena*. No doubt, if there was no such thing as the diffraction of light, if the telescopic image of a bright point was a point, if there was no dispersion of light through the atmosphere of *Venus*, then the definition of the true internal contact would be easy, and the

sharp cusps of *Venus* might then be seen without any blunting, rounding, or diffusion of the cusps. But we must accept the laws of nature as we find them, and no good, but much harm, will result from our ignoring the existence of causes which prevent the appearances which would be found to exist under the supposed laws of formal *geometrical* optics from being realised in the actual transit. We have already suffered too much from this error.

I am unable to follow Mr. Newcomb's remarks respecting Mr. Tebbutt's observations in 1874. There is no doubt that Mr. Tebbutt's "contact" at Ingress was observed rather later than the general "average contact," but there are later times still given for contact; and the error of Mr. Tebbutt's observation, as measured by the difference between the angular separation of the centres of *Venus* and the Sun at the time given and the mean angular separation, is only about two-tenths of a second of arc. The observation is therefore neither worthless nor very wild. At Egress the time given by Mr. Tebbutt corresponds to an angular separation of the centres which is nearly the mean angular separation of all the observers.

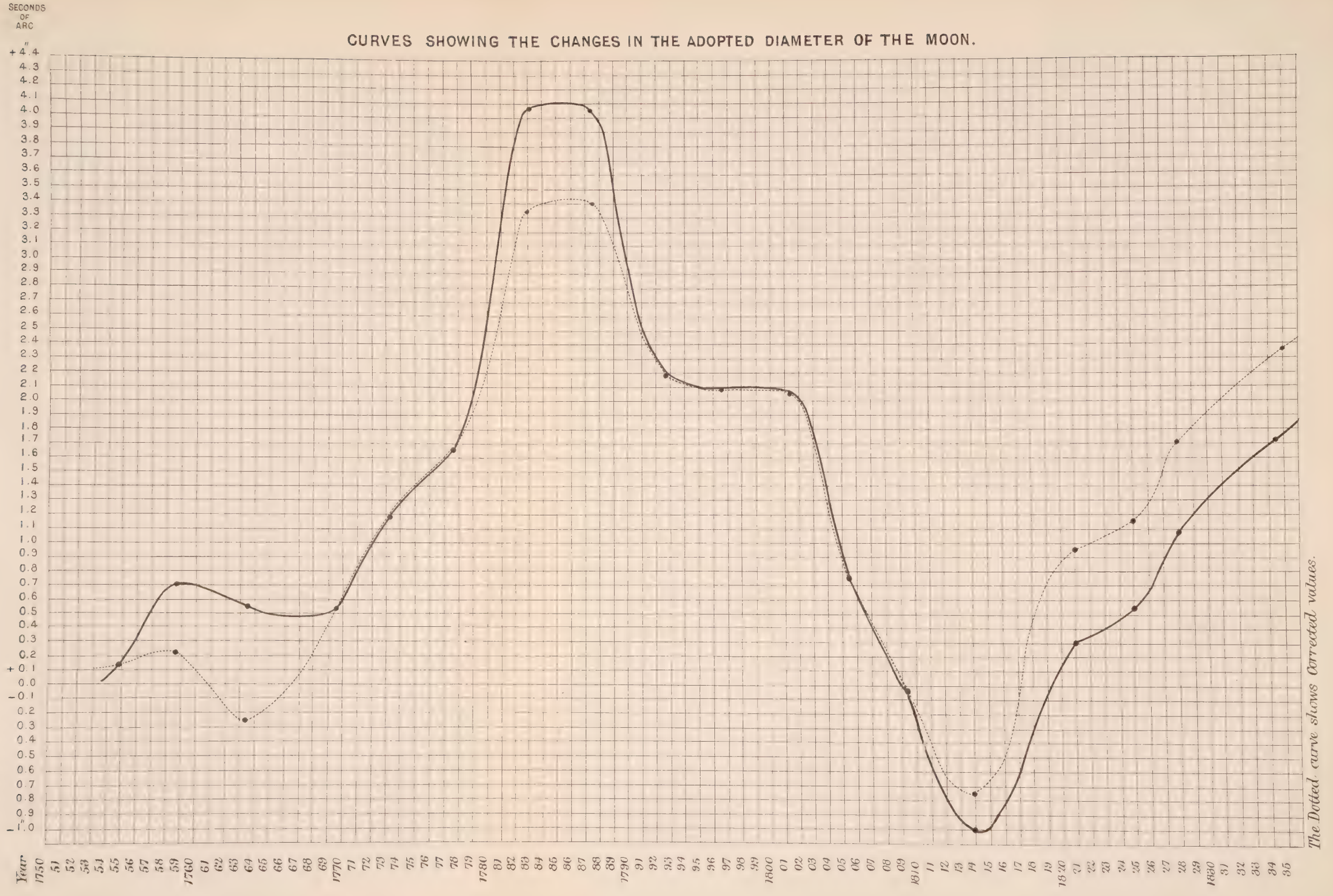
In conclusion, I would remark that if some approximation to uniformity in the instrumental equipments of the observers be secured—if good telescopes of nearly the same, and not too small, apertures be employed; if magnifying powers of not much less than 150 be used; if the observations of contact are made in fields of view of which the degree of illumination is not greatly in excess or defect; and if, above all, the attention of the observers is directed to a contact which is distinctive enough to be recognised: then, in my opinion, we may be certain of a substantial success, unless clouds should intervene and spoil the observations at several of the most important stations. To diminish this risk as much as possible, we have increased the number of stations; more we cannot do to insure and deserve success. But, whilst I feel confident of success if all the observers attempt to observe the same thing under somewhat similar conditions, if each observer is to observe any kind of contact which appears good in his own estimation, without reference to what is being done by other observers, then there must be as many values of the solar parallax deducible from attempts to combine these discordant observations as there are different kinds of contact observed at the opposed stations of accelerated and retarded effects of parallax.

In the paper of March 1877, *Monthly Notices* (vol. xxxvii.), to which Mr. Newcomb refers as explaining his views of the internal contact, the attention of the observers is directed to observing the first time at Ingress and last time at Egress when direct sunlight is seen all around *Venus*. Now, if such a definition should be adopted by the American observers, whilst the observers at the Cape, Madagascar, Australia, and New Zealand record the times when they last see "the illumination of the

Sun's limb near the point of contact as dark, or nearly as dark, as the outer edge of the planet," then an attempt to obtain a value of the Sun's parallax from a discussion of these observations, on the assumption that the contacts observed refer to the same angular separation of the limbs, will most certainly lead to a value of the solar parallax which is in excess of the true value. If the contacts observed were reversed at the different stations, then the result that would be obtained would be too small. I call attention to the point now, before the transit has taken place, in order, if possible, to prevent the serious confusion and doubt which may arise if any large number of observers are directed to observe a contact of an essentially different character from that which will be observed by the general body of the observers. If this caution is not attended to, it will be possible to obtain different values of the solar parallax by different combinations of the contacts; but of course no one entrusted with the calculations should attempt to combine in one discussion discordant material. It would, however, be far more satisfactory if the collection of this discordant material could be prevented rather than it should be rejected after the transit as worthless for the objects in view.

Curves showing the Changes in the Adopted Diameter of the Moon as given by the Observations in the Greenwich Lunar Reductions 1750–1830. By E. J. Stone, M.A., F.R.S.

The results upon which the curves are based have been extracted from "The Greenwich Lunar Reductions," vol. ii., Section iii., Comparison of Moon's Observed and Tabular Place, pages [1] to [293]. It is from a discussion of the results given in this section that the coefficients of the parallactic inequality were deduced by Sir G. B. Airy, which show an inequality with a period of about forty-six years. The observations have been divided into groups extending over periods of about nine years, identical with those adopted by Sir G. B. Airy. If E_1 and E_2 denote the excess of observed longitudes over tabular longitudes as deduced respectively from the observations of the first and second limbs, then E_1 and E_2 have been extracted directly from Section iii. for all the days on which both limbs were observed in Right Ascension and a North Polar Distance is available for the deduction of the observed longitude. The mean results are given in the following table. The results, divided by 2, will be found essentially the same as those which I have already given in the *Notices* for Dec. 1881, but in the former paper the results for the last year of each period were not included. In the present table the results of the last year of each group are included. The general form of the curve is not, however, altered by this difference in the grouping:—



Spottiswoode & Co Lith. London.

TABLE A.

	Group.	Mean Year.	No. of Obs.	Mean Value of $E_1 - E_2$	Second Set.
				"	"
1	1750–1759	1754·7	32	+0·145	+0·145
2	1755–1764	1758·8	28	+0·709	+0·222
3	1760–1768	1763·4	18	+0·546	−0·248
4	1765–1773	1769·5	16	+0·533	+0·533
5	1769–1778	1773·2	18	+1·184	+1·184
6	1774–1782	1777·8	16	+1·664	+1·664
7	1779–1787	1783·1	16	+4·069	+3·326
8	1783–1791	1787·4	18	+4·053	+3·397
9	1788–1796	1792·7	23	+2·179	+2·179
10	1792–1801	1796·7	23	+2·086	+2·086
11	1797–1805	1801·3	15	+2·053	+2·053
12	1802–1810	1805·3	13	+0·756	+0·756
13	1806–1815	1809·3	12	−0·027	−0·027
14	1811–1819	1814·0	8	−1·008	−0·768
15	1816–1824	1820·9	9	+0·314	+0·954
16	1820–1829	1825·0	17	+0·526	+1·166
17	1825–1833	1828·0	16	+1·083	+1·723
18	1830–1838	1834·7	11	+1·721	+2·361

The errors in the table may of course be affected by the existence of systematic errors in the North Polar Distance, for these observations are involved in the determination of the observed longitudes. There are two very large errors—

1763	Sept. 21	14"·05
1784	28	15·21

The rejection of these two results, and the correction of the results after 1816, August 7, for the slight difference between the adopted diameters before and after that period, lead to the second set of results.

The curves have been laid down from the above results with the mean values of $(E_1 - E_2)$ as ordinates, and the corresponding mean times as abscissæ.

On account of the importance of these results, from the use which has recently been made of these old Lunar Reductions, I have not only computed them myself, but I have also had them recomputed independently. I have no doubt whatever about the substantial accuracy of these results. But if correct, they *prove* conclusively that in these old observations, *as reduced*, we cannot pass from observations of the centre as deduced from the first limb of the Moon to observations of the centre as deduced from the second limb of the Moon without the large systematic and variable discordances which are indicated in the table and by the curves.

Addendum.

In the discussion between myself and Mr. Neison, we are concerned with the observations as reduced in Section iii., and to these I have confined my attention: but if the direct comparison between the times of passage of the diameter over the meridian as observed in Right Ascension did not indicate any such discordances as those found from the longitudes, then we should certainly be able to find the source of the error which has vitated the results as reduced. I have therefore computed the corrections to the provisionally adopted diameter which follow directly from the observations in R.A., as given on pages lxiv and lxv of the Introduction, vol. i. I have, however, found two editions of this Table: one marked *k*, the other marked **k*. My private copy is marked **k*. The Observatory copy is marked *k*. The copy at the Royal Society is marked *k*. The copy at the Royal Astronomical Society **k*. There is no doubt that the copy **k* is the more correct, and my results are derived from that copy. I have had the work done in duplicate, and I have examined it and it is substantially correct. There is only one unit in such inquiries in which the errors can be properly expressed, and that is in seconds of arc and the decimal parts of such a second. The errors in my table are therefore given in such units.

The following are the results:—

Table B.

	Group.	No. of Obs.	Corrections to Provisional Diameter.	Excess of Adopted Diameter over Observed.
1	1750-1759	34	+4″·686	−1″·012
2	1755–1764	29	+4·068	−0·394
3	1760–1768	19	+3 762	−0·088
4	1765–1773	18	+4·310	−0 636
5	1769–1778	22	+4·198	−0·524
6	1774–1782	18	+3·150	+0·524
7	1779–1787	16	+2·420	+1·254
8	1783–1791	18	+2·266	+1·408
9	1788–1796	24	+2·590	+1·084
10	1792–1801	24	+3·162	+0·512
11	1797–1805	15	+3·038	+0·636
12	1802–1810	13	+3·276	+0·398
13	1806–1815	12	+4·440	−0·766
14	1811–1819	8	+5·004	−1·330
15	1816–1824	9	+2·798	+0·876
16	1820–1829	17	+2·654	+1·020

The correction to provisional diameter to find adopted diameter is 3″·674. The results of this table are but slightly affected by any errors in the N.P.D. The corrections are certainly less in amount, but they follow the same general law as those given in Table A.

The deduced corrections to the adopted diameter do not sensibly agree amongst themselves for groups of observations extending over nine years. The errors are systematic. The diameters for a long period about 1783 are about a second of arc less, whilst those about 1765 are about half a second, and those about 1811 about a second of arc, greater than the mean value. It is certain, therefore, that if such corrections should be applied to coefficients of the parallactic inequality deduced from the series of observations, the result must be to strengthen the impression of the existence of a periodic term with a coefficient of about a second of arc and with a period of about forty-six years. And this is just what Mr. Neison found. (See *Notices*, 1880, May, pages 402–405.) Before corrections, such as those indicated, were applied, there appeared to be some indications of a periodic term in the coefficients of parallactic inequality with a coefficient of about a second of arc and a period of about thirty years; but after the application of corrections deduced from the observed durations, a periodic term was supposed to be found with a period of forty-six years.

My position with respect to the discussion is simply as follows: (1.) That I have shown that these old observations, as reduced, are affected with such systematic errors connected with the diameter that they cannot be applied with safety to the determination of values of the coefficients of the parallactic inequality until the source of these errors has been determined and the effects removed from the results given in Section iii. (2.) That the so-called forty-six-year period is certainly mainly due to the same sources of error which directly affect the diameters. (3.) That the introduction of an empirical periodic term with a coefficient of about a second of arc and a period of forty-six years as a *real term* in the expression for the tabular longitude of the Moon is a serious mistake, unless it can be justified by showing that the existence of such a term is a necessary consequence of the theory of gravitation. At present the only evidence in its favour is that such a term would approximately account for the appearance of some systematic discordance in the coefficients of the parallactic inequality as deduced from the results of Section iii. after correction for supposed errors of diameter. But it has been shown that these discordances are largely due to the errors of the diameters themselves; and the introduction of such a term in the longitude would not account for the existence of these errors in the diameter.

Until it has been shown that the results which I have given are substantially in error it will be useless for me to continue any discussion on these questions. They have already absorbed

much valuable time which I could ill spare, but the introduction of inequalities of long period into the expression of the Moon's longitude which are not necessary is a serious matter, and I have thought it desirable at all events to call attention to what I believe is a case in point.

On a supposed Periodical Term in the Values found for the Coefficient of the Parallactic Inequality. By E. Neison, Esq.

When Sir G. Airy determined the correction to the value of the parallactic inequality, he contented himself with applying a constant correction for error of semi-diameter for each of the two periods 1751–1815, and 1815–1839. But in the investigation undertaken by Mr. Campbell and myself, this was thought insufficient, and it was judged better to apply to each group of observations the correction to the tabular semi-diameter derived from the observations made during the same period. And it was shown that the values of the parallactic inequality when thus corrected strongly indicated the existence of a periodical term with a period of about forty-five years.

It is now objected that these corrections to the semi-diameter of the Moon exhibit a similar periodical term, and the conclusion is drawn that the term shown by the values of the parallactic inequality may have been introduced through the application of these corrections to the semi-diameter, and so be fictitious.

It became necessary to investigate this point.

To establish this objection it is not merely sufficient to show that there exists a periodical inequality in the correction applied for errors of semi-diameter, not even if it be shown that this inequality has a similar period; but it is imperative to show that in the correction applied for error of semi-diameter, there exists an inequality of the same value, period, and epoch as that found in the values of the parallactic inequality, and that when this inequality is eliminated from the corrections applied for errors of semi-diameter, the inequality also disappears from the values found for the parallactic inequality. Nothing less than this will serve to establish the conclusion it has been sought to draw.

From Sir G. Airy's reduction of the Greenwich observations ("Reduction of the Greenwich Lunar Observations," vol. i. pages lxiv–lxv) are derived the following corrections to the tabular semi-diameter of the Moon, divided into the same groups as those used for determining the correction to the parallactic inequality, and for convenience they have been expressed in terms of the same unit as employed by Sir George Airy:—

No.	Group.	No. of Obs.	Corr.	No.	Group.	No. of Obs.	Corr.
i.	1750–1759	34	+·684	v.	1769–1778	22	+·608
ii.	1755–1764	29	+·592	vi.	1774–1782	19	+·392
iii.	1760–1768	19	+·560	vii.	1779–1787	17	+·280
iv.	1765–1773	18	+·648	viii.	1783–1791	18	+·300

No.	Group.	No. of Obs.	Corr.	No.	Group.	No. of Obs.	Corr.
ix.	1788–1796	24	+·356	xv.	1816–1824	9	+·408
x.	1792–1801	24	+·472	xvi.	1820–1829	17	+·400
xi.	1797–1805	15	+·464	xvii.	1825–1833	16	+·376
xii.	1802–1808	13	+·472	xviii.	1830–1838	11	+·408
xiii.	1806–1815	12	+·628	xix.	1834–1842	14	+·580
xiv.	1811–1819	8	+·740	xx.	1839–1847	20	+·492

The periodical term in the values of the parallactic inequality was taken as having the approximate value

$$B \cos b = +0''.300 \cos \{8° \times [T - 1825·5]\}.$$

It was then assumed that a similar term existed in the above correction. In this manner each of the above values gave an equation of the form

$$S' + \cos b \times S'' = \text{correction to semi-diameter.}$$

This furnished twenty equations of condition, from which by the method of least squares there was derived the values

$$S' = +·490 \pm ·015; \qquad S'' = -·078 \pm ·022.$$

It was obvious, therefore, that the much greater value derived from the parallactic inequality could not have been introduced through the corrections to the semi-diameter. To render this unquestionable, the effect of this small inequality was altogether eliminated from the above corrections, by applying as the correction to the semi-diameter the quantity

$$\{\text{Correction to semi-diameter} - S'' \times \cos b\}.$$

The resulting values for the parallactic inequality furnished twenty equations of condition from which to determine B by the method of least squares. The result was

$$B = +·210 \pm ·040.$$

Thus, even after every trace of such an inequality had been eliminated from the values of the correction to the semi-diameter, the values of the parallactic inequality gave a coefficient three-fourths as large as before.

In the previous investigation, it was not thought necessary to attempt to attain any minute accuracy, as it was considered sufficient to adopt the first approximate determination of the value and period of this term. But from the first it was pointed out that by slightly altering the period and epochs of maximum, more accurate values could be obtained (see *Monthly Notices*, vol. xl. page 405). The previous investigation showed that the yearly motion of the argument should be slightly diminished, and instead of 8° it would be better to take $7\frac{1}{2}°$. It was assumed, therefore, that the argument was

$$b' = 7\tfrac{1}{2}^\circ \times [T - 1826{\cdot}0],$$

and each value of the correction to the tabular semi-diameter was equated to an expression of the form

$$S' + sS'' + \sin b'S''' + \cos b'S''''.$$

The second term $s\,S''$ was introduced to allow for the effect of any difference which might have been produced in the value of the semi-diameter from the change of instruments in 1816, it being supposed zero after that date. The resulting twenty equations were solved by the method of least squares and gave the following values:—

$$S' = +0{\cdot}528$$
$$S'' = -0{\cdot}017$$
$$S''' = -0{\cdot}109$$
$$S'''' = -0{\cdot}088$$

The periodical term had the form, therefore,

$$= -0{\cdot}140 \cos \{b' - 51^\circ{\cdot}1\}$$
$$= -0{\cdot}140 \cos \{7\tfrac{1}{2}^\circ \times [T - 1832{\cdot}9]\}.$$

It is obvious that this term is in amount far smaller and in epoch very different from that existing in the values of the parallactic inequality.

The effects of this assumed term were now eliminated as before from the correction to the semi-diameter applied to the parallactic inequality. The resulting twenty values of the parallactic inequality were then equated to expressions of the form

$$A + a + B' \sin b' + B'' \cos b',$$

and the resulting equations solved as before. The result was the values

$$A = +0{\cdot}599$$
$$a = -0{\cdot}585$$
$$B' = -0{\cdot}114$$
$$B'' = +0{\cdot}200$$

Hence the periodical term existing in the values of the parallactic inequality, after carefully eliminating any portion introduced through the correction to semi-diameter, is

$$= +0{\cdot}230 \cos \{b + 29^\circ{\cdot}6\}$$
$$= +0{\cdot}230 \cos \{7\tfrac{1}{2}^\circ \times [T - 1822{\cdot}1]\}.$$

This result completely confirms that previously obtained.

It may be remarked that the comparison with observation shows that this adopted period is somewhat too small, and that the observations would be best satisfied by the term

$$= +0{\cdot}240 \cos \{7\tfrac{2}{3}^\circ \times [T - 1824{\cdot}0]\}.$$

Converting into seconds of arc, this becomes

$$= +0''.96 \cos \{7\tfrac{2}{3}° \times [T - 1824.0]\}.$$

It remains now to see how far this value agrees with the results of the Greenwich observations since 1851. We have (*Monthly Notices*, vol. xli. page 262)

1851–1858	(P)	$= -123''.55$
1862–1869		$= -125.09$
1870–1876		$= -125.13$

Then applying the correction for this term, these become

1855.0	(P)	$= -123''.55 - .55B = -124''.08$	
1866.0		$= -125.09 + .79B = -124.33$	(A)
1873.5		$= -125.13 + .94B = -124.23$	

This term, therefore, still brings these three values into thorough accord.

If in obtaining the value for 1855.0, my own results be throughout adopted instead of using the Greenwich value for the correction to the semi-diameter—and this would perhaps be more satisfactory—then the result for this period must be increased by $0''.05$ bringing it up to $-124''.13$ in still better accord.

If the effects of any assumed term in the correction to the semi-diameter be neglected, the value of the term in the parallactic inequality becomes

$$+1''.12 \cos \{7\tfrac{2}{3}° \times [T - 1824.5]\},$$

and the three groups become

1855.0	(P)	$= -123''.55 - .49B = -124''.10$	
1866.0		$= -125.09 + .83B = -124.16$	(B)
1873.5		$= -125.13 + .91B = -124.11$	

These results may be regarded as showing quite clearly that this periodical term exists in the values of the parallactic inequality itself, and are not introduced by the corrections which have been applied for the errors of tabular semi-diameter.

London:
1882, *March* 25.

Addendum, 1882, June 1.—Since the preceding was written it has been shown by Mr. Stone (*Monthly Notices*, page 303) that the correction to Adams's value of the semi-diameter of the Moon, deduced by me from the observations of the years 1853–54–55, requires to be increased by $+0''.78$. As these comprise exactly a third of the total number of observations, the mean from the whole must be increased by $+0''.26$. Hence it

follows that the observed value differs from Adams's value by $+0''\cdot26-0''\cdot01=+0''\cdot25$ (*Monthly Notices*, vol. xlii. page 273).

The reduction of the observed values to the mean value depends on the theoretical expression for the parallax, and the same set of observed values will not necessarily yield the same mean value if reduced by different theoretical expressions for the parallax. The preceding results depend on the restricted expression given in the *Nautical Almanack* for 1856. Had the much more elaborate expression of Hansen's been used, a slightly different value would have been obtained. According to my calculations, the difference amounts to $-0''\cdot15$ (see *Monthly Notices*, xli. page 418). Hence to reduce these earlier results to the same basis as the later ones—*i.e.* Hansen's Tables—the correction to the semidiameter which should be used is $+0''\cdot25-0''\cdot15=+0''\cdot10$, instead of $-0''\cdot18$, that actually used. The difference $+0''\cdot28$ represents the correction which must be applied to the value of the parallactic inequality found from the observations of the years 1851–1858 (*Monthly Notices*, xli. page 262). Hence the correct value is

$$(P) \quad =-\{123''\cdot55+0''\cdot28\}=-123''\cdot83.$$

Using this value, the comparison (A) of the value of the parallactic inequality for the three periods becomes

1855·0	(P)	$=-123''\cdot83-\cdot55B=-124''\cdot36$	
1866·0		$=-125\cdot09+\cdot79B=-124\cdot33$	(C)
1873·5		$=-125\cdot13+\cdot94B=-124\cdot23$	

These agree better than before.

Remarques à propos des récentes observations de M. Schiaparelli sur la planète Mars. Par le Docteur F. Terby, de Louvain.

En présence des discussions qui surgissent au sujet des remarquables découvertes de M. Schiaparelli, j'ai cru utile de bien préciser, dans une courte notice, quelques faits qui ne devraient point être perdus de vue par les Aréographes et qui ont une importance capitale dans le débat :—

Je ferai d'abord observer que M. Burton, dans une lettre adressée à l'*Astron. Reg.* No. 233, p. 116, dit explicitement avoir *vu* et *identifié* le *Lethes*, l'*Astapus*, l'*Astabaras*, le *Phison*, le *Nilus*, l'*Indus* et l'*Oxus*; d'après cette lettre, il y aurait donc accord complet entre les observations de Loughlinstown et de Milan, du moins pour les canaux précités (v. aussi *Copernicus*, Nos. 16 et 17, pp. 92 et 93).

Je ne sais si M. Proctor, dans sa lettre au *Times*, a mentionné des canaux vus par M. Dawes, autres que ceux qui figurent dans sa carte générale; je crois cela fort peu probable; je puis donc dire que ce serait une profonde erreur de penser que les canaux

de M. Dawes n'ont pas été revus par M. Schiaparelli et ont disparu depuis. Au contraire, *tous les canaux* figurés par M. Dawes sont aujourd'hui reconnus et identifiés par l'astronome de Milan. Comme je l'ai déjà fait remarquer ailleurs, la découverte de Milan ne fait que développer un caractère que M. Dawes avait déjà consigné dans ses dessins, en y insérant les *passes* de *Bessel*, de *Nasmyth*, de *Dawes*, de *Huggins*, qui, bien loin d'avoir disparu, sont aujourd'hui l'*Iridis*, le *Nilus*, l'*Hydaspes*, le *Cyclopum*. Les petites mers de *Lassell* et de *Le Verrier* elles-mêmes semblent s'identifier avec le *Ganges* et avec le *Chrysorrhoas*. Et si nous ajoutons à cela l'*Oudemans Inlet* remplacé par l'*Eunostos*, la *mer de Main* devenue aujourd'hui le *Nepenthes*, le canal reliant la *mer de Lockyer* à l'*océan De la Rue*, nommé par M. Schiaparelli *Nectaris*, la mer de Dawes devenue l'*Agathodæmon*, je crois que nous aurons retrouvé dans la carte de Milan tout ce qui ressemble à des canaux dans les dessins de M. Dawes. Je serais heureux toutefois d'apprendre que M. Proctor possède d'autres dessins inédits de Dawes, renfermant d'autres canaux, et, dans ce cas, j'en demanderais instamment la publication.

Une autre erreur est de croire que les canaux vus par M. Burton en 1879 ne coincident pas suffisamment bien avec certains canaux vus à la même époque par M. Schiaparelli ; il me semble, en effet, que l'identification est très-facile dans la plupart des cas, et je crois que quiconque étudiera soigneusement la carte de M. Burton sera du même avis.

Enfin, il ne faut pas croire que la carte la plus récente de M. Schiaparelli, celle de 1881–82, est en contradiction avec ses cartes antérieures, et que le système de canaux vu en 1879 n'y est qu'à peine reconnaissable ; pour moi l'identité est complète et *tous* les canaux de 1879 et de 1877 sont fidèlement reproduits et identifiés en 1881–82. Le merveilleux et mystérieux phénomène de la *gémination* ne trouble pas cette identité, quoiqu'il en paraisse. Prenons des exemples : en 1879, nous voyons partir de la *baie de Schmidt* (point 61 de M. Schiaparelli) le canal *Phison* qui se dirige droit vers le *Colœ Palus* ; en 1881 rien n'est changé à ce parcours, mais d'un point situé un peu au nord et sur l'*Euphrates*, part un second canal, nouveau, et c'est ce canal qui court parallèlement au *Phison*, et va aboutir, non pas au *Colœ Palus*, mais à un autre point du *Nil*. Voilà *la gémination du Phison*. Du point marqué 25, part, en 1879, le canal *Titanum*. En 1881, ce canal se trouve exactement dans la même position, mais d'un point situé sur le *Gigantum*, canal voisin, se détache un canal nouveau qui court parallèlement au *Titanum* et c'est encore la *gémination*. Il en est de même de tous les canaux que j'examine sur la carte photographiée que M. Schiaparelli a eu l'extrême obligeance de m'envoyer.

Fait bien remarquable, la présence du Nilus *et du* Nilus II., *en* 1879, *entre le* Ganges *et le* Ceraunius sinus, *était déjà un indice de la gémination qui, sur la carte de* 1881–82, *se montre encore plus évidente dans cette région.*

Après cette simple constatation de faits je demanderai aussi s'il est possible d'admettre que l'*Indus*, à peu près aussi large, et certainement aussi noir que la *mer de Kaiser* en 1881–82, peut n'être que la limite de deux régions inégalement sombres ou diversement colorées, imparfaitement vues ou imparfaitement distinguées l'une de l'autre ?

Measures of the Companion to Sirius. By S. W. Burnham, Esq.

During the present season I have made the following measures of the companion to *Sirius* :—

1881·835	42°·6	9″·72	
81·840	43·9	9·56	
81·843	43·6	9·20	
81·859	43·1	8·87	
81·865	43·2	9·62	
82·085	47·4	9·48	
82·088	44·4	9·64	
82·102	43·6	9·11	
82·104	43·4	9·35	
82·145	41·7	9·25	
82·148	43·0	9·36	
Mean = 1881·99	43·6	9·38	11 nights.

The measures taken in 1881, the first five of the series, were made with the 12-inch Refractor of the Lick Observatory at Mount Hamilton. The other measures were made with the 18½-inch Refractor of the Dearborn Observatory.

Chicago :
1882, *May* 3.

On the Variable Star U Cephei. By George Knott, LL.B., B.A.

I succeeded in getting observations of four minima of U *Cephei* in March and April last, the results of which I give below, together with a comparison of the observed times with those deduced by carrying on Dr. Schmidt's Ephemeris (*A. N.* 2382) by the aid of his period 2·49277 days. In accordance with the practice generally adopted in the case of variable stars, the times are reduced to Paris Mean Time, by adding $9^{m}\cdot3$ to the G. M. T. of observation, which was read off from the light-curve to the nearest minute. The observations show that the period is subject to irregularities—a result quite in accordance with those obtained by other observers.

Min. Observed.	Min. Calc.	C−O.	Obs. Mag.
d h m	h m	m	
1882, March 18 12 30·3	12 9·3	−21·0	9·5
April 7 11 14·3	10 45·9	−28·4	9·45
22 10 14·3	9 43·5	−30·8	9·5
27 9 54 3	9 22·7	−31 6	9·45

As is well known, the minima of this variable occur in sets, alternate minima being observable at intervals of about five days. The intermediate minima are observed when the next set comes round. For convenience I will call these A and B sets. From an examination of my observations I have a strong suspicion that there is a difference of about three-tenths of a magnitude between the minimum magnitude reached in the A and B sets respectively. I have now observed two sets of each, and in the following table give the magnitudes observed by me in the minima of each set respectively:—

A_1 Set.	B_1 Set.	A_2 Set.	B_2 Set.
m	m	m	m
9·1	9·4	9·2	9·5
9·1	9·4	9·2	9·45
9·2	9·4	9·2	9·5
9·1	9·4	9·25	9·45
	9·4		
	9·4		

The dates of the several sets are: *—

A_1	1880, Oct. 23	—	1881, Jan. 6
B_1	1881, Mar. 29	—	May 8
A_2	Sept. 27	—	Dec. 21
B_2	1882, Mar. 18	—	1882, April 27

The differences, though not great, are so fairly consistent as to lead me to think that they can hardly be due to accident merely. If further observation should confirm my suspicion, it would appear that we must regard the period as a double one.

Professor Pickering in his "Photometric Measurements of the Variable Stars *β Persei* and D.M. 81° 25" (the latter being U *Cephei*) remarks of a neighbouring star D. M. 81° 18 that it "is either variable or its light in grades is erroneously given by M. Glasenapp." My own observations show that this star is certainly variable to the extent of some six-tenths of a magnitude, but I am unable as yet to see my way to any suggestion as to its probable period.

Knowles Lodge, Cuckfield:
1882, *June* 8.

* The dates given are those of the first and last minimum observed in each set.

Ephemeris for Physical Observations

Greenwich Noon. 1882.	Angle of Position of ♃'s Axis.	Latitude of Earth above ♃'s Equator.	Latitude of Sun above ♃'s Equator.	Annual Parallax A—L.	O—L.	Long. of ♃'s Central Meridian.
	°	°	°	°	°	°
Aug. 2	357·538	+2·551	+2·680	−8·445	52·319	108·08
7	357·973	2·537	2·669	8 946	51·381	139·53
12	358·392	2·524	2·657	9·411	50·479	171·03
17	358·792	2·511	2·645	9·836	49·618	202·59
22	359·173	2·498	2·633	10·216	48·802	234·21
27	359·531	2·485	2 621	10·549	48·033	265·88
Sept. 1	359·866	+2·473	+2·609	−10·832	47·315	297·62
6	0·175	2·462	2·597	11·060	46·652	329·42
11	0·457	2·451	2·584	11·229	46·047	1·29
16	0·711	2·441	2·572	11·337	45·504	33·23
21	0·933	2·431	2·559	11·380	45·028	65·24
26	1·123	2·423	2·546	11·353	44·621	97·31
Oct. 1	1·278	+2·415	+2·533	−11·252	44·288	129·46
6	1·398	2·409	2·520	11·075	44·031	161·69
11	1·481	2·403	2·506	10·819	43·854	193·98
16	1·525	2·399	2·493	10·482	43·758	226·34
21	1·531	2·395	2·479	10·062	43·746	258·78
26	1·498	2·392	2·466	9·558	43·817	291·28
31	1·426	2·390	2·452	8·972	43·972	323·85
Nov. 5	1·316	+2·389	+2·438	−8·303	44·209	356·48
10	1·168	2·389	2·424	7·554	44·526	29·17
15	0·985	2·389	2·409	6·730	44·920	61·91
20	0·769	2·389	2·395	5·837	45·382	94·69
25	0·524	2·389	2·381	4·882	45·907	127·49
30	0·255	2·389	2·366	3·874	46·485	160·31
Dec. 5	359·965	+2·388	+2·351	−2·822	47·108	193·14
10	359·659	2·387	2·336	1·738	47·762	225·97
15	359·345	2·384	2·321	−0·634	48·436	258·77
20	359·027	2·381	2·306	+0·476	49·117	291·55
25	358·713	2·377	2 291	1·578	49·791	324·28
30	358·408	2·372	2·276	2·661	50·446	356·94

of Jupiter, 1882–83. By A. Marth, Esq.

Corr. for Phase.	Equat. Diam.	Phase pr. limb.	Polar Diam.	Diff. of Limbs in R.A.	Phase pr. limb.	*d*.	*w*.	Greenwich Noon. 1882.
°	″	″	″	s	s	°	°	
+0·31	34·28	0·19	32·10	2·479	0·013	8·44	268·86	Aug. 2
·35	34·63	·21	32·43	2·505	·015	8 94	268·88	7
·38	35·01	·24	32·78	2·533	·017	9·40	268·91	12
·42	35·41	·26	33·16	2 563	·019	9·83	268·93	17
·45	35·84	·28	33·56	2·594	·021	10·21	268·94	22
·48	36·30	·31	33·99	2·627	·022	10·54	268·96	27
+0·51	36·78	0·33	34·44	2·663	0·024	10·82	268·98	Sept. 1
·55	37·19	·35	34·92	2·701	·025	11·05	268·99	6
·55	37·83	·36	35·43	2·740	·026	11·22	269·01	11
·56	38·39	·37	35·96	2·781	·027	11·33	269·03	16
·56	38·98	·38	36·50	2·823	·028	11·37	269·05	21
·56	39·58	·39	37·06	2·866	·028	11·34	269·07	26
+0·55	40·20	0·39	37·64	2·911	0·028	11·24	269·10	Oct. 1
·53	40·83	·38	38·24	2·957	·028	11·06	269·13	6
·51	41·48	·37	38 84	3 003	·027	10·81	269·17	11
·48	42·12	·35	39·44	3·050	·025	10·47	269·21	16
·44	42·76	·33	40·04	3·097	·024	10·05	269·26	21
·40	43·39	·30	40·63	3·143	·022	9·55	269·32	26
·35	44·01	·27	41·21	3·187	·020	8·96	269·38	31
+0·30	44·60	0·23	41·76	3 230	0·017	8·29	269·46	Nov. 5
·25	45·15	·20	42·28	3·271	·014	7·55	269·55	10
·20	45·66	·16	42·76	3·308	·011	6·72	269·66	15
·15	46·12	·12	43·19	3·341	·009	5·83	269·81	20
·11	46·51	·08	43·55	3·370	·006	4·88	270·01	25
·07	46·84	·05	43·85	3·393	·004	3·87	270·27	30
+0·04	47·08	0·03	44·08	3·411	0 002	2·82	270·76	Dec. 5
+ ·01	47·24	·01	44·24	3·423	·001	1·74	271·73	10
·00	47·31	·00	44·31	3·428	·000	0·62	276·12	15
·00	47·29	foll. 1	44·29	3·426	foll. 1	0·48	80·33	20
− ·01	47·18	·01	44·18	3·418	·001	1·58	86·70	25
·03	46·99	·03	44·00	3·403	·002	2 66	87·83	30

Greenwich Noon. 1883.		Angle of Position of ♃'s Axis.	Latitude of Earth | Sun above ♃'s Equator.		Annual Parallax A−L.	O−L.	Long. of ♃'s Central Meridian.
		°	°	°	°	°	°
Jan.	4	358·117	+2·366	+2·260	+3·713	51·069	29·54
	9	357·847	2·359	2·245	4·721	51·650	62·06
	14	357·603	2·350	2·229	5·677	52·177	94·48
	19	357·387	2·341	2·213	6·566	52·641	126·82
	24	357·204	2·330	2·197	7·385	53·034	159·05
	29	357·057	2·319	2·181	8·131	53·352	191·18
Feb.	3	356·947	+2·307	+2·165	+8·796	53·591	223·20
	8	356·874	2·294	2·149	9·378	53·748	255·12
	13	356·840	2·281	2·133	9·875	53·820	286·94
	18	356·846	2·267	2·116	10·288	53·807	318·65
	23	356·890	2·253	2·100	10·617	53·711	350·27
	28	356·972	2·238	2·083	10·864	53·534	21·80
Mar.	5	357·091	+2·223	+2·066	+11·031	53·277	53·25
	10	357·245	2·207	2·049	11·122	52·944	84·61
	15	357·433	2·191	2·032	11·139	52·537	115·90
	20	357·654	2·174	2·015	11·086	52·061	147·12
	25	357·906	2·157	1·998	10·967	51·520	178·28
	30	358·187	2·139	1·981	10·787	50·917	209·38
Apr.	4	358·495	+2·121	+1·964	+10·549	50·256	240·43
	9	358·829	2·102	1·946	10·256	49·541	271·43
	14	359·186	2·082	1·929	9·912	48·776	302·40
	19	359·565	2·062	1·911	9·522	47·964	333·34
	24	359·965	2·041	1·893	9·089	47·110	4·25
	29	0·383	2·019	1·875	8·617	46·218	35·13
May	4	0·817	+1·996	+1·857	+8·110	45·290	66·00
	9	1·267	1·973	1·839	7·569	44·330	96·85
	14	1·730	1·949	1·821	6·997	43·339	127·69
	19	2·204	1·924	1·813	6·397	42·318	158·53

Corr. for Phase.	Equat. Diam.	Phase pr. limb.	Polar Diam.	Diff. of Limbs in R.A.	Phase pr. limb.	*d.*	*w.*	Greenwich Noon. 1883.
°	″	″	″	s	s	°	°	
−0·06	46·71	0·05	43·74	3·382	0·004	3·71	88·30	Jan. 4
·10	46·35	·08	43·40	3·356	·006	4·72	88·62	9
·14	45·92	·11	43·00	3·325	·008	5·67	88·82	14
·19	45·43	·15	42·54	3·289	·011	6·56	88·94	19
·24	44·88	·19	42·03	3·249	·013	7·38	89·05	24
·29	44·30	·22	41·48	3·207	·016	8·12	89·14	29
−0·34	43·68	0·26	40·90	3·162	·019	8·79	89·20	Feb. 3
·38	43·03	·29	40·30	3·115	·021	9·37	89·25	8
·42	42·37	·31	39·68	3·068	·023	9·87	89·28	13
·46	41·71	·33	39·05	3·020	·024	10·28	89·31	18
·49	41·04	·35	38·42	2·972	·025	10·61	89·33	23
·51	40·37	·36	37·80	2·925	·026	10·85	89·35	28
−0·53	39·72	0·37	37·19	2·878	·027	11·02	89·35	Mar. 5
·54	39·08	·37	36·59	2·832	·027	11·11	89·35	10
·54	38·46	·36	36·01	2·787	·026	11·13	89·34	15
·53	37·86	·35	35·45	2·745	·026	11·08	89·34	20
·52	37·28	·34	34·91	2·704	·025	10·96	89·33	25
·51	36·73	·32	34·39	2·665	·024	10·78	89·31	30
−0·49	36·20	0·31	33·90	2·627	·022	10·54	89·29	Apr. 4
·46	35·71	·29	33·43	2·592	·021	10·25	89·27	9
·43	35·24	·26	32·99	2·559	·019	9·91	89·24	14
·39	34·79	·24	32·58	2·527	·017	9·52	89·21	19
·36	34·38	·22	32·20	2·498	·016	9·08	89·17	24
·32	34·00	·19	31·84	2·470	·014	8·61	89·14	29
−0·29	33·64	0·17	31·51	2·444	0·012	8·11	89·10	May 4
·25	33·32	·15	31·20	2·421	·011	7·57	89·06	9
·21	33·02	·12	30·92	2·399	·009	6·99	89·01	14
−0·18	32·75	0·10	30·67	2·379	0·007	6·39	88·96	19

The "Annual Parallax," A−L, is the difference of the Jovicentric longitudes of the Sun and the Earth, reckoned in the plane of *Jupiter's* equator; the angle O − L is the difference of longitudes of *Jupiter's* vernal equinoctial point O and of the point of his equator which is in opposition to the Earth, or 180°+L−O is the Jovicentric longitude of the Earth reckoned from O.

The daily rate of rotation, on which the "Longitude of ♃'s Central Meridian" depends, is that adopted in last year's Ephemeris—namely, 870°·42—the corresponding period being $9^h\ 55^m\ 34^s{\cdot}47$. As the motion of the great reddish spot is not uniform, but slackening, it will be better for the present purpose not to make any alteration. The successive values of the Long. of C. Mer. differ, for an interval of five days, by twelve rotations and some thirty degrees, so that, for instance, the first difference is 4351°·45 and the last 4350°·84, which must be borne in mind in interpolating. If the "Corr. for Phase" is added to the "Longitude of ♃'s Central Meridian," or of the meridian directed to the Earth, the longitude of the meridian is found which bisects the illuminated disk of *Jupiter*. A list of the Greenwich mean times, when the adopted First (or Zero) Meridian passes the middle of the disk, will be given further on.

The assumed value of *Jupiter's* equatorial diameter is 37″·60 at the distance 5·20273. The assumed proportion of the polar axis to the equatorial diameter is 0·9363. As during the present apparition the axis of *Jupiter* is little inclined to the circle of declination, the difference of limbs in declination does not sensibly differ from the polar diameter, and the defect of illumination or the phase in declination is insensible. The last columns give the values of the auxiliary angles d and w required in the computations, as explained in vol. xl. p. 490 ff.

The inclinations γ and the ascending nodes Γ of the orbits of the four satellites in reference to the plane of *Jupiter's* equator are the following, the nodes being reckoned from O, the point of the vernal equinox of *Jupiter's* northern hemisphere:—

1882.	Sat. I.		Sat. II.		Sat. III.		Sat. IV.	
	γ_1	Γ_1	γ_2	Γ_2	γ_3	Γ_3	γ_4	Γ_4
	°	°	°	°	°	°	°	°
Aug. 2	0·0112	342·2	0·4783	344·04	0·1688	259·97	0·3228	331·06
Oct. 1	·0111	340·5	·4789	342·10	·1677	259·46	·3219	331·06
Nov. 30	·0110	338·8	·4794	340·16	·1667	258·94	·3210	331·05
1883.								
Jan. 29	·0110	337·0	·4799	338·22	·1658	258·53	·3201	331·01
Mar. 30	·0109	335·1	·4804	336·28	·1649	257·92	·3193	330·96
May 29	·0109	333·0	·4809	334·33	·1641	257·42	·3187	330·87

If these values of Γ are added to the elongations O−L of the point O from superior conjunction, given before, the angles Γ+O−L are the elongations of the ascending nodes of the orbits from superior conjunction; and the latitudes of the satellites above the plane of *Jupiter's* equator are easily found, if their elongations are known.

The following is a list of the Greenwich mean times, when the assumed First Meridian of *Jupiter* passes the middle of the illuminated disk:—

1882.	h	m	1882.	h	m	1882.	h	m	1882.	h	m
Aug. 2	16	52·0	Aug. 18	0	11·0	Sept. 2	7	29·2	Sept. 17	14	46·5
3	2	47·6		10	6·7		17	24·8	18	0	42·0
	12	43·3		20	2·3	3	3	20·4		10	37·6
	22	39·0	19	5	57·9		13	16·1		20	33·2
4	8	34·6		15	53·6		23	11·7	19	6	28·8
	18	30·3	20	1	49·2	4	9	7·3		16	24·3
5	4	25·9		11	44·8		19	2·9	20	2	19·9
	14	21·6		21	40·5	5	4	58·5		12	15·5
6	0	17·2	21	7	36·1		14	54·1		22	11·1
	10	12·9		7	31·7	6	0	49·7	21	8	6·7
	20	8·6	22	3	27·4		10	45·3		18	2·3
7	6	4·2		13	23·0		20	40·9	22	3	57·9
	15	59·9		23	18·6	7	6	36·5		13	53·5
8	1	55·5	23	9	14·3		16	32·1		23	49·0
	11	51·2		19	9·9	8	2	27·7	23	9	44·6
	21	46·8	24	5	5·5		12	23·3		19	40·2
9	7	42·5		15	1·2		22	18·9	24	5	35·8
	17	38·1	25	0	56·8	9	8	14·6		15	31·4
10	3	33·8		10	52·4		18	10·2	25	1	26·9
	13	29·4		20	48·1	10	4	5·8		11	22·5
	23	25·1	26	6	43·7		14	1·4		21	18·1
11	9	20·7		16	39·3		23	57·0	26	7	13·7
	19	16·4	27	2	34·9	11	9	52·6		17	9·2
12	5	12·0		12	30·6		19	48·2	27	3	4 8
	15	7·7		22	26·2	12	5	43·8		13	0·4
13	1	3·3	28	8	21·8		15	39·3		22	55·9
	10	59·0		18	17·4	13	1	34·9	28	8	51·5
	20	54·6	29	4	13·0		11	30·5		18	47·1
14	6	50·3		14	8·7		21	26·1	29	4	42·6
	16	45·9	30	0	4·3	14	7	21·7		14	38·2
15	2	41·5		9	59·9		17	17·3	30	0	33·8
	12	37·2		19	55·5	15	3	12·9		10	29·3
	22	32·8	31	5	51·1		13	8·5		20	24·9
16	8	28·5		15	46·7		23	4·1	Oct. 1	6	20·5
	18	24·1	Sept. 1	1	42·4	16	8	59·7		16	16·0
17	4	19·7		11	38·0		18	55·3	2	2	11·6
	14	15·4		21	33·6	17	4	50·9		12	7·2

1882.	h	m	1882.	h	m	1882.	h	m	1882.	h	m
Oct. 2	22	2·7	Oct. 19	1	9·1	Nov. 4	4	14·3	Nov. 20	7	18·6
3	7	58·3		11	4·6		14	9·8		17	14·1
	17	53·8		21	0·1	5	0	5·3	21	3	9·6
4	3	49·4	20	6	55·7		10	0·8		13	5·1
	13	45·0		16	51·2		19	56·3		23	0·5
	23	40·5	21	2	46·7	6	5	51·8	22	8	56·0
5	9	36·1		12	42·2		15	47·3		18	51·5
	19	31·6		22	37·8	7	1	42·8	23	4	47·0
6	5	27·2	22	8	33·3		11	38·3		14	42·5
	15	22·7		18	28·8		21	33·8	24	0	38·0
7	1	18·3	23	4	24·4	8	7	29·3		10	33·5
	11	13·9		14	19·9		17	24·8		20	28·9
	21	9·4	24	0	15·4	9	3	20·3	25	6	24·4
8	7	5·0		10	10·9		13	15·8		16	19·9
	17	0·5		20	6·5		23	11·3	26	2	15·4
9	2	56·1	25	6	2·0	10	9	6·8		12	10·9
	12	51·6		15	57·5		19	2·3		22	6·3
	22	47·2	26	1	53·0	11	4	57·8	27	8	1·8
10	8	42·7		11	48·5		14	53·3		17	57·3
	18	38·3		21	44·1	12	0	48·8	28	3	52·8
11	4	33·8	27	7	39·6		10	44·3		13	48·3
	14	29·3		17	35·1		20	39·8		23	43·8
12	0	24·9	28	3	30·6	13	6	35·3	29	9	39·2
	10	20·4		13	26·1		16	30·8		19	34·7
	20	16·0		23	21·6	14	2	26·3	30	5	30·2
13	6	11·5	29	9	17·2		12	21·8		15	25·7
	16	7·1		19	12·7		22	17·3	Dec. 1	1	21·2
14	2	2·6	30	5	8·2	15	8	12·8		11	16·6
	11	58·2		15	3·7		18	8·2		21	12·1
	21	53·7	31	0	59·2	16	4	3·7	2	7	7·6
15	7	49·2		10	54·7		13	59·2		17	3·1
	17	44·8		20	50·2		23	54·7	3	2	58·5
16	3	40·3	Nov. 1	6	45·8	17	9	50·2		12	54·0
	13	35·9		16	41·3		19	45·7		22	49·5
	23	31·4	2	2	36·8	18	5	41·2	4	8	45·1
17	9	26·9		12	32·3		15	36·7		18	40·5
	19	22·5		22	47·8	19	1	32·2	5	4	35·9
18	5	18·0	3	8	23·3		11	27·6		14	31·4
	15	13·5		18	18·8		21	23·1	6	0	26·9

1882.	h	m
Dec. 6	10	22·4
	20	17·9
7	6	13·3
	16	8·8
8	2	4·3
	11	59·8
	21	55·2
9	7	50·7
	17	46·2
10	3	41·7
	13	37·2
	23	32·6
11	9	28·1
	19	23·6
12	5	19·1
	15	14·6
13	1	10·0
	11	5·5
	21	1·0
14	6	56·5
	16	52·0
15	2	47·4
	12	42·9
	22	38·4
16	8	33·9
	18	29·4
17	4	24·9
	14	20·3
18	0	15·8
	10	11·3
	20	6·8
19	6	2·3
	15	57·7
20	1	53·2
	11	48·7
	21	44·2
21	7	39·7
	17	35·2
22	3	30·7

1882.	h	m
Dec. 22	13	26·1
	23	21·6
23	9	17·1
	19	12·6
24	5	8·1
	15	3·6
25	0	59·1
	10	54·6
	20	50·1
26	6	45·6
	16	41·1
27	2	36·6
	12	32·1
	22	27·6
28	8	23·1
	18	18·6
29	4	14·1
	14	9·6
30	0	5·1
	10	0·6
	19	56·1
31	5	51·6
	15	47·1

1883.	h	m
Jan. 1	1	42·6
	11	38·2
	21	33·7
2	7	29·2
	17	24·7
3	3	20·2
	13	15·2
	23	11·2
4	9	6·8
	19	2·3
5	4	57·8
	14	53·3
6	0	48·8
	10	44·4
	20	39 9

1883.	h	m
Jan. 7	6	35·4
	16	30·9
8	2	26·5
	12	22·0
	22	17·5
9	8	13·0
	18	8·6
10	4	4·1
	13	59·6
	23	55·2
11	9	50·7
	19	46·2
12	5	41·8
	15	37·3
13	1	32·8
	11	28·4
	21	23·9
14	7	19·5
	17	15·0
15	3	10·6
	13	6·1
	23	1·7
16	8	57·2
	18	52·8
17	4	48·3
	14	43·9
18	0	39·4
	10	35·0
	20	30·5
19	6	26·1
	16	21·6
20	2	17·2
	12	12·7
	22	8·3
21	8	3·9
	17	59·4
22	3	55·0
	13	50·6
	23	46·1

1883.	h	m
Jan. 23	9	41·7
	19	37·3
24	5	32·8
	15	28·4
25	1	24·0
	11	19·6
	21	15·1
26	7	10·7
	17	6·3
27	3	1·9
	12	57·4
	22	53·0
28	8	48·6
	18	44·2
29	4	39·8
	14	35·4
30	0	31·0
	10	26·5
	20	22·1
31	6	17·7
	16	13·3
Feb. 1	2	8·9
	12	4·5
	22	0·1
2	7	55·0
	17	51·3
3	3	46·9
	13	42·5
	23	38·1
4	9	33·7
	19	29·3
5	5	24·9
	15	20·5
6	1	16·1
	11	11·7
	21	7·3
7	7	2·9
	16	58·5
8	2	54·2

1883.	h	m	1883.	h	m	1883.	h	m	1883.	h	m
Feb. 8	12	49·8	Feb. 24	15	59·5	Mar. 12	19	10·7	Mar. 28	22	22·9
	22	45·4	25	1	55·2	13	5	6·4	29	8	18·7
9	8	41·0		11	50·8		15	2·0		18	14·4
	18	36·6		21	46·5	14	0	57·7	30	4	10·1
10	4	32·2	26	7	42·1		10	53·4		14	5·8
	14	27·8		17	37·8		20	49·1	31	0	1·5
11	0	23·5	27	3	33·4	15	6	44·8		9	57·2
	10	19·1		13	29·1		16	40·5		19	52·9
	20	14·7		23	24·8	16	2	36·2	Apr. 1	5	48·7
12	6	10·3	28	9	20·4		12	31·9		15	44·4
	16	5·9		19	16·1		22	27·6	2	1	40·1
13	2	1·6	Mar. 1	5	11·8	17	8	23·3		11	35·8
	11	57 2		15	7·4		18	19·0		21	31·5
	21	52·8	2	1	3·1	18	4	14·6	3	7	27·2
14	7	48·5		10	58·8		14	10·3		17	23·0
	17	44·1		20	54·4	19	0	6·0	4	3	18·7
15	3	39·7	3	6	50·1		10	1·7		13	14·4
	13	35·4		16	45·8		19	57·4		23	10·1
	23	31·0	4	2	41·4	20	5	53·1	5	9	5·8
16	9	26·6		12	37·1		15	48·8		19	1·5
	19	22·3		22	32·8	21	1	44·5	6	4	57·3
17	5	17·9	5	8	28·4		11	40·2		14	53·0
	15	13·5		18	24·1		21	35·9	7	0	48·7
18	1	9·2	6	4	19·8	22	7	31·6		10	44·4
	11	4·8		14	15·5		17	27·3		20	40·2
	21	0·5	7	0	11·1	23	3	23·0	8	6	35·9
19	6	56·1		10	6·8		13	18·7		16	31·6
	16	51·7		20	2·5		23	14·4	9	2	27·3
20	2	47·4	8	5	58·2	24	9	10·2		12	23·0
	12	43·0		15	53·9		19	5·9		22	18 8
	22	38·7	9	1	49·5	25	5	1·6	10	8	14·5
21	8	34·3		11	45·2		14	57·3		18	10·2
	18	30·0		21	40·9	26	0	53·0	11	4	5·9
22	4	25·6	10	7	36·6		10	48·7		14	1·7
	14	21·3		17	32·3		20	44·4		23	57·4
23	0	16·9	11	3	27·9	27	6	40·1	12	9	53·1
	10	12·6		13	23·6		16	35·8		19	48·9
	20	8·2		23	19·3	28	2	31·5	13	5	44·6
24	6	3·9	12	9	15·0		12	27·2		15	40·3

1883.	h	m	1883.	h	m	1883.	h	m	1883.	h	m
Apr. 14	1	36·0	Apr. 22	18	6·4	May 1	10	36·8	May 10	3	7·4
	11	31·7		23	4	2·1		20	32·6		13	3·1
	21	27·5			13	57·8	2	6	28·3		22	58·8
15	7	23·2			23	53·6		16	24·0	11	8	54·6
	17	18·9	24	9	49·3		3	2	19·8		18	50·3
16	3	14·7			19	45·0		12	15·5	12	4	46·1
	13	10·4	25	5	40·8			22	11·3		14	41·8
	23	6·1			15	36·5	4	8	7·0	13	0	37·6
17	9	1·8	26	1	32·2			18	2·7		10	33·3
	18	57·6			11	28·0	5	3	58·5		20	29·0
18	4	53·3			21	23·7		13	54·2	14	6	24·8
	14	49·0	27		7	19·4		23	50·0		16	20·5
19	0	44·8			17	15·2	6	9	45·7	15	2	16·3
	10	40·5	28	3	10·9			19	41·4		12	12·0
	20	36·2			13	6·7	7	5	37·2		22	7·8
20	6	32·0			23	2·4		15	32·9	16	8	3·5
	16	27·7	29	8	58·1		8	1	28·7		17	59·2
21	2	23·4			18	53·9		11	24·4	17	3	55·0
	12	19·2	30	4	49·6			21	20·1		13	50·7
	22	14·9			14	45·3	9	7	15·9		23	46·5
22	8	10·6	May 1	0	41·1			17	11·6	18	9	42·2

In case the rate of slackening in the motion of the great reddish spot should continue, the preceding end of the spot will be near the middle of the disk, when observations become feasible in August, about 40 or 50 minutes after the passages of the assumed First Meridian, and the interval will then slowly increase.

Ephemerides of the Satellites of Saturn, August to November 1882. By A. Marth, Esq.

The following ephemerides of the five inner satellites are founded upon the same elements which have served in the preparation of the ephemerides (published in *Astron. Nachrichten*) for the last apparitions of *Saturn*, as the conjunctions in right ascension of the satellites with the planet's centre, observed by Prof. Asaph Hall, and published on page 308 of the *Monthly Notices*, indicate that the elements are sufficiently near the truth for the present purpose. The five satellites deviate so little from the plane of the ring, that it will be most suitable to treat their deviation as latitudes above this plane, the ascending node N and inclination J of which in reference to the plane of the Earth's equator being here assumed to be

1882, Aug.	2	N = 126°·4424	J = 7°·0157
Sept.	1	·4446	·0154
Oct.	1	·4467	·0152
	31	·4499	·0151
Nov.	20	126·4545	7·0148

the longitudes N of the node being reckoned from the point of the true equinox.

The assumed longitudes of the satellites in their orbits (*i.e.* their longitudes from the ascending node added to the right ascension N of the ascending node), referring to the time when the light arrives at the distance, the logarithm of which is 0·950, are the following:

0^h Gr.	*Mimas.*	*Enceladus.*	*Tethys.*	*Dione.*	*Rhea.*
1882, Aug. 2	193°·238	320°·442	350°·024	263°·960	149°·920
Sept. 1	132·956	282·399	310·969	250·012	20·625
Oct. 1	72·675	244·355	271·913	236·063	251·329
31	12·395	206·312	232·857	222·115	122·033
Nov. 30	312·116	168·269	193·801	208·167	352·737

The adopted daily sidereal motions of the five satellites and the corresponding times of their sidereal revolutions are:

		d h m s
Mimas	381°·99063	0 22 37 6·08
Enceladus	262·73186	1 8 53 6·86
Tethys	190·69812	1 21 18 25·96
Dione	131·53503	2 17 41 9·33
Rhea	79·69012	4 12 25 11·87

The values for the latter four satellites were given at the end of the ephemerides for 1877 in the *Astr. Nachr.* No. 2155. The values for *Mimas* belong to Oct. 1, 1882, and depend on the hypothesis of accelerated motion introduced in the ephemeris for 1880, *Astr. Nachr.* No. 2328. The question must at present, and till proper observations are available, remain an open one.

In the following tables P is the position-angle of the minor axis of the ring; L+180° the planetocentric longitude of the Earth referred to the plane of the ring; Λ+180° that of the Sun or Λ−L the difference between the two. The apparent equatorial diameter of the ball and the diameter of the outer rim of the ring depend on Bessel's determinations 17″·053 and 39″·311 for the distance, the logarithm of which is 0·9796480. The assumed proportion of the polar axis of the ball to the equatorial diameter is 0 : 900.

In the tables for the satellites *a* and *b* are the semi-axes of the apparent orbits, their values depending on Bessel's deter-

mination of the major axis of the orbit of *Titan*, and $l-L$ are the longitudes of the satellites in their orbits reckoned from the points which are in superior conjunction with the planet's centre or are in opposition to the Earth in longitude.

The values of P, a, b and $l-L$ are to be interpolated for the times for which the apparent positions of the satellites are required, and the rectangular coordinates x and y, reckoned parallel to the axes of the ring and expressed in seconds of arc, or, if polar-coordinates are wanted, the position-angles p and distances s of the satellites in reference to the centre of the planet, are then found by

$$s \sin (p-P) = x = a \sin (l-L)$$
$$s \cos (p-P) = y = b \cos (l-L).$$

0h Gr.	P	L	Latitude of Earth above plane of ring.	Latitude of Sun above plane of ring.	A−L
1882.	°	°			°
Aug. 2	357·795	53·981	−23·616	−22·186	−6·486
7	357·756	54·294	23·659	22·234	6·610
12	357·723	54·565	23·693	22·282	6·692
17	357·695	54·793	23·718	22·330	6·730
22	357·673	54·976	23·734	22·378	6·723
27	357·656	55·113	23·741	22·425	6·670
Sept. 1	357·645	55·203	−23·740	−22·473	−6·570
6	357·640	55·245	23·731	22·520	6·422
11	357·641	55·239	23·713	22·566	6·225
16	357·648	55·184	23·687	22·613	5·979
21	357·661	55·082	23·654	22·660	5·686
26	357·680	54·934	23·612	22·706	5·347
Oct. 1	357·704	54·740	−23·563	−22·752	−4·963
6	357·733	54·504	23·507	22·798	4·536
11	357·768	54·228	23·445	22·843	4·068
16	357·807	53·915	23·377	22·888	3·563
21	357·850	53·570	23·304	22·933	3·025
26	357·897	53·196	23·226	22·978	2·460
31	357·946	52·800	23·145	23·023	1·872
Nov. 5	357·998	52·386	−23·062	−23·067	−1·265
10	358·051	51·960	22·978	23·112	0·646
15	358·105	51·529	22·893	23·156	−0·022
20	358·159	51·098	22·809	23·199	+0·601
25	358·212	50·674	22·728	23·243	1·218
30	358·264	50·263	22·651	23·286	+1·822

0^h Gr.	Diam. of Ball Equat.	Phase. pr. *l.*	Polar.	Axis of Ring Major.	Minor.	*Mimas.* a_1	b_1	l_1-L	Diff.
1882.	″	″	″	″	″	″	″	°	°
Aug. 2	17·37	0·056	15·93	40·05	16·04	27·32	−10·94	138·26	1909·82
7	17·52	·058	16·07	40·40	16·21	27·56	11·06	248·08	·86
12	17·68	·060	16·21	40·75	16·38	27·80	11·17	357·94	·90
17	17·84	·061	16·36	41·12	16·54	28·05	11·28	107·84	1909·96
22	18·00	·062	16·51	41·50	16·70	28·31	11·39	217·80	1910·00
27	18·17	·061	16·66	41·88	16·86	28·57	11·50	327·80	·04
Sept. 1	18·34	·060	16·81	42·27	17·02	28·83	−11·61	77·84	1910·08
6	18·50	·058	16·96	42·65	17·16	29·09	11·71	187·92	·13
11	18·67	·055	17·12	43·03	17·30	29·35	11·80	298·05	·18
17	18·83	·051	17·26	43·40	17·44	29·61	11·89	48·23	·21
21	18·99	·047	17·41	43·77	17·56	29·86	11·98	158·44	·25
26	19·14	·042	17·55	44·12	17·67	30·09	12·05	268·69	·29
Oct. 1	19·28	·036	17·68	44·45	17·77	30·32	−12·12	18·98	1910·32
6	19·42	·031	17·80	44·76	17·85	30·53	12·18	129·30	·34
11	19·54	·025	17·91	45·04	17·92	30·73	12·22	239·64	·37
16	19·65	·020	18·01	45·30	17·97	30·90	12·26	350·01	·39
21	19·75	·015	18·10	45·52	18·01	31·05	12·28	100·40	·40
26	19·83	·010	18·17	45·70	18·02	31·18	12·29	210·80	·41
31	19·89	·005	18·22	45·85	18·02	31·28	12·29	321·21	·41
Nov. 5	19·94	·003	18·26	45·96	18·00	31·35	−12·28	71·62	1910·40
10	19·96	·001	18·29	46·02	17·96	31·39	12·25	182·02	·39
15	19·97	foll. l.	18·29	46·04	17·91	31·40	12·22	292·41	·37
20	19·96	·001	18·28	46·01	17·84	31·39	12·17	42·78	·35
25	19·93	·003	18·25	45·94	17·75	31·34	12·11	153·13	·32
30	19·88	0·005	18·20	45·83	17·65	31·26	−12·04	263·45	1910·29

0^h Gr.	*Enceladus.* a_2	b_2	l_2-L	Diff.	*Tethys.* a_3	b_3	l_3-L	Diff.
1882.	″	″	°	°	″	″	°	°
Aug. 2	35·05	−14·04	265·77	1313·47	43·38	−17·38	295·54	953·27
7	35·35	14·19	139·24	·51	43·76	17·56	168·81	·31
12	35·66	14·33	12·75	·56	44·15	17·74	42·12	·35
17	35·99	14·48	246·31	·60	44·55	17·92	275·47	·40
22	36·32	14·62	119·91	·65	44·96	18·10	148·87	·45
27	36·65	14·76	353·56	·69	45·37	18·27	22·32	·49
Sept. 1	36·99	−14·89	227·25	1313·74	45·79	−18·43	255·81	953·54
6	37·32	15·02	100·99	·78	46·20	18·59	129·35	·58
11	37·66	15·14	334·77	·83	46·61	18·75	2·93	·63
16	37·98	15·26	208·60	·87	47·02	18·89	236·56	·67
21	38·30	15·37	82·47	·91	47·71	19·02	110·23	·71
26	38·61	15·46	316·38	·95	47·79	19·14	343·94	·75

Enceladus.

0^h Gr. 1882.	a_2	b_2	l_2-L	Diff.
	″	″	°	°
Oct. 1	38·90	−15·55	190·33	
				1313·99
6	39·17	15·62	64·32	
				1314·01
11	39·42	15·68	298·33	·04
16	39·64	15·73	172·37	·07
21	39·83	15·76	46·44	·08
26	40·00	15·77	280·52	·10
31	40·12	15·77	154·62	·10
Nov. 5	40·22	−15·75	28·72	
				1314·10
10	40·27	15·72	262·82	·10
15	40·29	15·67	136·92	·08
20	40·26	15·61	11·00	·07
25	40·20	15·53	245·07	·04
30	40·10	−15·44	119·11	
				1314·01

Tethys.

0^h Gr. 1882.	a_3	b_3	l_3-L	Diff.
	″	″	°	°
Oct. 1	48·15	−19·25	217·69	
				953·79
6	48·49	19·34	91·48	·83
11	48·79	19·41	325·31	·85
16	49·07	19·47	199·16	·88
21	49·31	19·51	73·04	·90
26	49·51	19·53	306·94	·92
31	49·67	19·52	180·86	·93
Nov. 5	49·78	−19·50	54·79	
				953·93
10	49·85	19·46	288·72	·92
15	49·87	19·40	162·64	·92
20	49·84	19·32	36·56	·90
25	49·77	19·23	270·46	·88
30	49·64	−19·12	144·34	
				953·85

Dione.

0^h Gr. 1882.	a_4	b_4	l_4-L	Diff.
	″	″	°	°
Aug. 2	55·56	−22·26	209·64	
				657·42
7	56·05	22·49	147·06	·47
12	56·54	22·72	84·53	·51
17	57·06	22·95	22·04	·55
22	57·58	23·18	319·59	·60
27	58·11	23·40	257·19	·65
Sept. 1	58·64	−23·61	194·84	
				657·69
6	59·17	23·81	132·53	·74
11	59·70	24·01	70·27	·79
16	60·22	24·19	8·06	·83
21	60·72	24·36	305·89	·87
26	61·21	24·52	243·76	·92
Oct. 1	61·67	−24·65	181·68	
				657·96
6	62·10	24·77	119·64	657·99
11	62·49	24·86	57·63	658·02
16	62·85	24·94	355·65	·05
21	63·15	24·98	293·70	·08
26	63·41	25·01	231·78	·09
31	63·61	25·01	169·87	·10
Nov. 5	63·76	−24·98	107·97	
				658·11
10	63·85	24·92	46·08	·11
15	63·87	24·85	344·19	·10
20	63·84	24·75	282·29	·09
25	63·74	24·63	220·38	·08
30	63·58	−24·49	158·46	
				658·05

Rhea.

0^h Gr. 1882.	a_5	b_5	l_5-L	Diff.
	″	″	°	°
Aug. 2	77·59	−31·08	95·73	
				398·17
7	78·27	31·41	133·90	·22
12	78·96	31·73	172·12	·26
17	79·68	32·05	210·38	·31
22	80·41	32·36	248·69	·35
27	81·15	32·67	287·04	·40
Sept. 1	81·89	−32·97	325·44	
				398·45
6	82·63	33·26	3·89	·49
11	83·37	33·53	42·38	·54
16	84·10	33·79	80·92	·58
21	84·80	34·02	119·50	·63
26	85·48	34·24	158·13	·68
Oct. 1	86·12	−34·43	196·81	
				398·71
6	86·72	34·59	235·52	·75
11	87·27	34·72	274·27	·79
16	87·76	34·82	313·06	·81
21	88·19	34·89	351·87	·84
26	88·55	34·92	30·71	·86
31	88·84	34·92	69·57	·87
Nov. 5	89·04	−34·88	108·44	
				398·88
10	89·16	34·81	147·32	·89
15	89·20	34·70	186·21	·88
20	89·15	34·56	225·09	·87
25	89·01	34·39	263·96	·85
30	88·79	−34·19	302·81	
				398·83

Approximate Greenwich Mean Times of conjunctions of the satellites with the centre of *Saturn*:

"*n*" inferior conj. with centre, or satellite exactly in the direction of the minor axis of the ring, north, moving from the following to the preceding side.

"*s*" superior conjunction, or satellite south, moving from the preceding to the following side.

1882.	h		1882.	h		1882.	h	
Aug. 3	1·4	Rh. n.	Aug. 14	14·7	Te. n.	Aug. 23	9·5	Rh. s.
	3·4	Di. s.		16·6	En. s.		14·4	En. n.
	6·8	Te. n.	15	9·1	En. n.		16·2	Di. n.
4	5·4	Te. s.		11·1	Di. n.		18·9	Mi. n.
	12·3	Di. n.		13·3	Te. s.	24	1·2	Te. n.
5	4·1	Te. n.	16	12·0	Te. n.		6·8	En. s.
	7·6	Rh. s.		14·8	Rh. n.		17·5	Mi. n.
	21·1	Di. s.		17·2	Mi. s.		23·3	En. n.
6	2·7	Te. s.		17·9	En. n.		23·9	Te. s.
7	1·4	Te. n.		20·0	Di. s.	25	1·1	Di. s.
	6·0	Di. n.	17	10·4	En. s.		15·7	En. s.
	13·9	Rh. n.		10·6	Te. s.		15·7	Rh. n.
	20·2	En. s.		15·8	Mi. s.		16·1	Mi. n.
8	0·1	Te. s.	18	4·8	Di. n.		22·5	Te. n.
	12·6	En. n.		9·3	Te. n.	26	8·1	En. n.
	14·9	Di. s.		14·5	Mi. s.		9·9	Di. n.
	22·7	Te. n.		19·3	En. s.		14·7	Mi. n.
9	20·1	Rh. s.		21·1	Rh. s.		21 2	Te. s.
	21·4	Te. s.	19	7 9	Te. s.	27	13·3	Mi. n.
	21·5	En. n.		11·7	En. n.		17·0	En. n.
	23·7	Di. n.		13·1	Mi. s.		18·7	Di. s.
10	13·9	En. s.		13·7	Di. s.		19·8	Te. n.
	20·0	Te. n.	20	6·6	Te. n.		22·0	Rh. s.
11	6·4	En. n.		11·7	Mi. s.	28	9·5	En. s.
	8·6	Di. s.		20·6	En. n.		11·9	Mi. n.
	18·7	Te. s.		22·5	Di. n.		18·5	Te. s.
	22·8	En. s.	21	3·3	Rh. n.	29	3·6	Di. n.
12	2·4	Rh. n.		5·3	Te. s.		10·6	Mi. n.
	15·3	En. n.		13·0	En. s.		17·1	Te. n.
	17·4	Te. n.		21·6	Mi. n.		18·4	En. s.
	17·4	Di. n.	22	3·9	Te. n.		21·9	Mi. s.
13	7·7	En. s.		7·4	Di. s.	30	4·2	Rh. n.
	16·0	Te. s.		20·2	Mi. n.		10·8	En. n.
14	2·3	Di. s.		21·9	En. s.		12·4	Di. s.
	8·6	Rh. s.	23	2·6	Te. s.		15·8	Te. s.

1882.	h		
Aug. 30	20·5	Mi.	s.
31	14·5	Te.	n.
	19·1	Mi.	s.
	19·7	En.	n.
	21·3	Di.	n.
Sept. 1	10·4	Rh.	s.
	12·1	En.	s.
	13·1	Te.	s.
	17·7	Mi.	s.
2	6·1	Di.	s.
	11·8	Te.	n.
3	10·4	Te.	s.
	13·4	En.	n.
	15·0	Di.	n.
	16·6	Rh.	n.
4	9·1	Te.	n.
	13·6	Mi.	s.
	22·3	En.	n.
	23·8	Di.	s.
5	7·7	Te.	s.
	12·2	Mi.	s.
	14·8	En.	s.
	22·8	Rh.	s.
6	6·4	Te.	n.
	7·2	En.	n.
	8·6	Di.	n.
	10·8	Mi.	s.
7	5·0	Te.	s.
	9·4	Mi.	s.
	16·1	En.	n.
	17·5	Di.	s.
	20·7	Mi.	n.
8	3·7	Te.	n.
	5·0	Rh.	n.
	8·5	En.	s.
	19·3	Mi.	n.
9	2·3	Di.	n.
	2·3	Te.	s.
	17·4	En.	s.
	18·0	Mi.	n.

1882.	h		
Sept. 10	1·0	Te.	n.
	9·9	En.	n.
	11·2	Di.	s.
	11·2	Rh.	s.
	16·6	Mi.	n.
	23·6	Te.	s.
11	15·2	Mi.	n.
	18·7	En.	n.
	20·0	Di.	n.
	22·3	Te.	n.
12	11·2	En.	s.
	13·8	Mi.	n.
	17·4	Rh.	n.
	20·9	Te.	s.
13	4·8	Di.	s.
	12·4	Mi.	n.
	19·6	Te.	n.
	20·1	En.	s.
14	11·0	Mi.	n.
	12·5	En.	n.
	13·7	Di.	n.
	18·2	Te.	s.
	23·6	Rh.	s.
15	16·9	Te.	n.
	21·0	Mi.	s.
	21·4	En.	n.
	22·5	Di.	s.
16	13·8	En.	s.
	15·5	Te.	s.
	19·6	Mi.	s.
17	5·8	Rh.	n.
	7·4	Di.	n.
	14·2	Te.	n.
	18·2	Mi.	s.
	22·7	En.	s.
18	12·8	Te.	s.
	15·1	En.	n.
	16·2	Di.	s.
	16·8	Mi.	s.
19	7·6	En.	s.

1882.	h		
Sept. 19	11·5	Te.	n.
	12·0	Rh.	s.
	15·4	Mi.	s.
20	1·0	Di.	n.
	10·1	Te.	s.
	14·0	Mi.	s.
	16·5	En.	s.
21	8·8	Te.	n.
	8·9	En.	n.
	9·9	Di.	s.
	12·7	Mi.	s.
	18·2	Rh.	n.
22	7·4	Te.	s.
	11·3	Mi.	s.
	17·8	En.	n.
	18·7	Di.	n.
23	6·1	Te.	n.
	9·9	Mi.	s.
	10·2	En.	s.
24	0·4	Rh.	s.
	3·5	Di.	s.
	4·7	Te.	s.
	19·1	En.	s.
	19·8	Mi.	n.
25	3·4	Te.	n.
	11·5	En.	n.
	12·4	Di.	n.
	18·4	Mi.	n.
26	2·0	Te.	s.
	6·6	Rh.	n.
	17·0	Mi.	n.
	20·4	En.	n.
	21·2	Di.	s.
27	0·7	Te.	n.
	12·9	En.	s.
	15·7	Mi.	n.
	23·3	Te.	s.
28	6·0	Di.	n.
	12·8	Rh.	s.
	14·3	Mi.	n.

1882.	h		1882.	h		1882.	h	
Sept. 28	21·7	En. s.	Oct. 9	19·6	Rh. n.	Oct. 18	18·4	Di. s.
	22·0	Te. n.		20·8	En. s.		18·4	En. n.
29	14·9	Di. s.	10	5·7	Te. n.		20·3	Rh. n.
	20·6	Te. s.		8·9	Mi. s.	19	10·9	En. s.
30	18·9	Rh. n.		13·2	En. n.		16·2	Te. n.
	19·3	Te. n.		13·5	Di. s.		19·1	Mi. s.
	23·7	Di. n.		20·2	Mi. n.	20	3·3	Di. n.
Oct. 1	15·5	En. s.	11	4·4	Te. s.		14·8	Te. s.
	17·9	Te. s.		5·6	En. s.		17·7	Mi. s.
2	7·9	En. n.		18·9	Mi. n.		19·8	En. s.
	8·5	Di. s.		22·1	En. n.	21	2·4	Rh. s.
	16·5	Te. n.		22·3	Di. n.		12·1	Di. s.
3	1·1	Rh. s.	12	1·8	Rh. s.		12·2	En. n.
	15·2	Te. s.		3·0	Te. n.		13·5	Te. n.
	16·8	En. n.		14·5	En. s.		16·3	Mi. s.
	17·3	Di. n.		17·5	Mi. n.	22	12·1	Te. s.
	18·6	Mi. s.	13	1·7	Te. s.		14·9	Mi. s.
4	9·2	En. s.		6·9	En. n.		20·9	Di. n.
	13·8	Te. n.		7·1	Di. s.		21·1	En. n.
	17·3	Mi. s.		16·1	Mi. n.	23	8·6	Rh. n.
5	2·2	Di. s.	14	0·3	Te. n.		10·7	Te. n
	7·3	Rh. n.		8·0	Rh. n.		13·5	En. s.
	12·5	Te. s.		14·7	Mi. n.		13·5	Mi. s.
	15·9	Mi. s.		15·8	En. n.	24	5·7	Di. s.
	18·1	En. s.		16·0	Di. n.		5·9	En. n.
6	10·6	En. n.		22·9	Te. s.		9·4	Te. s.
	11·0	Di. n.	15	8·3	En. s.		12·1	Mi. s.
	11·1	Te. n.		13·3	Mi. n.		22·4	En. s.
	14·5	Mi. s.		21·6	Te. n.	25	8·0	Te. n.
7	9·8	Te. s.	16	0·8	Di. s.		10·8	Mi. s.
	13·1	Mi. s.		11·9	Mi. n.		14·5	Di. n.
	13·5	Rh. s.		14·1	Rh. s.		14·8	Rh. s.
	19·4	En. n.		17·1	En. s.		14·8	En. n.
	19·8	Di. s.		20·2	Te. s.	26	6·7	Te. s.
8	8·4	Te. n.	17	9·6	En. n.		7·3	En. s.
	11·7	Mi. s.		9·6	Di. n.		9·4	Mi. s.
	11·9	En. s.		10·5	Mi. n.		23·4	Di. s.
9	4·7	Di. n.		18·9	Te. n.	27	5·3	Te. n.
	7·1	Te. s.	18	9·2	Mi. n.		20·9	Rh. n.
	10·3	Mi. s.		17·5	Te. s.	28	4·0	Te. s.

1882.	h		
Oct.	28	8·2	Di. n.
	29	2·6	Te. n.
		16·5	Mi. n.
		17·0	Di. s.
		17·4	En. n.
	30	1·2	Te. s.
		3·1	Rh. s.
		9·9	En. s.
		15·1	Mi. n.
		23·9	Te. n.
	31	1·8	Di. n.
		13·7	Mi. n.
		18·8	En. s.
		22·5	Te. s.
Nov.	1	9·2	Rh. n.
		10·7	Di. s.
		11·2	En. n.
		12·4	Mi. n.
		21·2	Te. n.
	2	11·0	Mi. n.
		19·5	Di. n.
		19·8	Te. s.
		20·1	En. n.
	3	9·6	Mi. n.
		12·5	En. s.
		15·4	Rh. s.
		18·5	Te. n.
	4	4·3	Di. s.
		4·9	En. n.
		8·2	Mi. n.
		17·1	Te. s.
		19·5	Mi. s.
		21·4	En. s.
	5	13·1	Di. n.
		13·8	En. n.
		15·7	Te. n.
		18·1	Mi. s.
		21·5	Rh. n.
	6	6·2	En. s.
		14·4	Te. s.

1882.	h		
Nov.	6	16·7	Mi. s.
		21·9	Di. s.
		22·7	En. n.
	7	13·0	Te. n.
		15·1	En. s.
		15·3	Mi. s.
	8	3·7	Rh. s.
		6·8	Di. n.
		7·6	En. n.
		11·7	Te. s.
		14·0	Mi. s.
	9	10·3	Te. n.
		12·6	Mi. s.
		15·6	Di. s.
		16·4	En. n.
	10	8·9	En. s.
		9·0	Te. s.
		9·8	Rh. n.
		11·2	Mi. s.
	11	0·4	Di. n.
		7·6	Te. n.
		9·8	Mi. s.
		17·7	En. s.
	12	6·2	Te. s.
		8·4	Mi. s.
		9·2	Di. s.
		10·2	En. n.
		16·0	Rh. s.
	13	4·9	Te. n.
		7·0	Mi. s.
		18·1	Di. n.
		18·3	Mi. n.
		19·1	En. n.
	14	3·5	Te. s.
		5·6	Mi. s.
		11·5	En. s.
		16·9	Mi. n.
		22·1	Rh. n.
	15	2·2	Te. n.
		2·9	Di. s.

1882.	h		
Nov.	15	3·9	En. n.
		15·5	Mi. n.
		20·4	En. s.
	16	0·8	Te. s.
		11·7	Di. n.
		12·8	En. n.
		14·2	Mi. n.
		23·5	Te. n.
	17	4·3	Rh. s.
		5·2	En. s.
		12·8	Mi. n.
		20·5	Di. s.
		21·7	En. n.
		22·1	Te. s.
	18	11·4	Mi. n.
		14·1	En. s.
		20·8	Te. n.
	19	5·3	Di. n.
		6·6	En. n.
		10·0	Mi. n.
		10·4	Rh. n.
		19·4	Te. s.
	20	8·6	Mi. n.
		14·2	Di. s.
		15·4	En. n.
		18·0	Te. n.
	21	7·2	Mi. n.
		7·9	En. s.
		16·6	Rh. s.
		16·7	Te. s.
		23·0	Di. n.
	22	15·3	Te. n.
		16·7	En. s.
	23	7·8	Di. s.
		9·2	En. n.
		14·0	Te. s.
		22·7	Rh. n.
	24	12·6	Te. n.
		16·6	Di. n.
		18·1	En. n.

1882.	h		1882.	h		1882.	h	
Nov. 25	10·5	En. s.	Nov. 27	10·2	Mi. s.	Nov. 29	7·4	Mi. s.
	11·3	Te. s.		10·3	Di. n.		13·1	En. s.
	13·0	Mi. s.		11·8	En. n.		18·7	Mi. n.
26	1·5	Di. s.	28	4·2	En. s.	30	3·9	Di. n.
	4·9	Rh. s.		7·2	Te. n.		4·5	Te. n.
	9·9	Te. n.		8·3	Mi. s.		5·6	En. n.
	11·6	Mi. s.		11·1	Rh. n.		17·2	Rh. s.
	19·4	En. s.		19·1	Di. s.			
27	8·5	Te. s.	29	5·8	Te. s.			

By means of this list of conjunctions, approximate values of the coordinates x and y, expressed in semi-diameters of the planet's equator, may be easily found for any other time t in the following little table, the argument of which is the interval τ between the time t and the time of the nearest (preceding or following) conjunction.

	Mimas.		*Enceladus.*		*Tethys.*		*Dione.*		*Rhea.*	
τ h	x	y	x	y	x	y	x	y	x	y
0	0·0	1·2	0·0	1·6	0·0	2·0	0·0	2·5	0·0	3·5
1	0·9	1·2	0·8	1·6	0·7	2·0	0·6	2·5	0·5	3·5
2	1·7	1·0	1·5	1·5	1·4	1·9	1·2	2·5	1·0	3·5
3	2·3	0·8	2·2	1·3	2·0	1·8	1·8	2·4	1·5	3·5
4	2·8	0·5	2·8	1·1	2·6	1·7	2·4	2·3	2·0	3·4
5	3·1	0·2	3·3	0·9	3·2	1·5	2·9	2·2	2·5	3·4
6	3·1		3·7	0·6	3·7	1·3	3·5	2·1	3·0	3·3
7	2·9		3·9	0·3	4·1	1·1	4·0	2·0	3·5	3·2
8	2·5		4·0	0·1	4·5	0·9	4·4	1·8	4·0	3·2
9					4·7	0·7	4·8	1·7	4·5	3·1
10					4·9	0·4	5·2	1·5	4·9	3·0
11					5·0	0·1	5·6	1·3	5·3	2·9
12							5·8	1·0	5·7	2·7
13							6·1	0·8	6·1	2·6
14							6·2	0·6	6·5	2·5
15							6·3	0·3	6·8	2·3
16							6·4	0·1	7·1	2·1
18									7·7	1·8
20									8·2	1·4
27									8·9	0·0

Differences of Right Ascension and Declination between Iapetus and the Centre of Saturn.

0h Gr. 1882.	α−A s	δ−D ″	0h Gr. 1882.	α−A s	δ−D ″
Aug. 2	−24·10	−187·0	Sept. 7	34·84	192·5
3	22·05	188·4	8	33·49	198·8
4	19·85	188·5	9	31·95	204·0
5	17·50	187·3	10	30·22	208·0
6	15·02	184·9	11	+28·30	+210·8
7	12·43	181·3	12	26·21	212·4
8	9·76	176·5	13	23·96	212·8
9	7·01	170·5	14	21·56	211·9
10	4·21	163·4	15	19·03	209·8
11	− 1·37	155·2	16	16·37	206·4
12	+ 1·50	−146·0	17	13·61	201·8
13	4·36	135·8	18	10·76	196·0
14	7·21	124·7	19	7·83	188·9
15	10·03	112·8	20	4·84	180·7
16	12·80	100·1	21	+ 1·81	+171·4
17	15·49	86·7	22	− 1·24	161·0
18	18·10	72·7	23	4·29	149·5
19	20·61	58·3	24	7·33	137·1
20	23·00	43·4	25	10·33	123·8
21	25·27	28·2	26	13·28	109·7
22	+27·39	− 12·8	27	16·15	94·8
23	29·35	+ 2·7	28	18·93	79·3
24	31·14	18·3	29	21·59	63·2
25	32·76	33·9	30	24·12	46·6
26	34·19	49·3	Oct. 1	−26·50	+ 29·7
27	35·42	64·4	2	28·72	+ 12·6
28	36·45	79·3	3	30·75	− 4·7
29	37·27	93 7	4	32·58	22·0
30	37·88	107·6	5	34·20	39·3
31	38·27	121·0	6	35·59	56·3
Sept. 1	+38·44	+133·7	7	36·74	72·9
2	38·39	145·7	8	37·64	89·1
3	38·12	156·9	9	38·28	104·8
4	37·62	167·3	10	38·66	119·7
5	36 91	176·7	11	−38·77	−133·9
6	35·98	185·1	12	38·61	147·1

0h Gr.	α—A	δ—D	0h Gr.	α—A	δ—D
1882.	s	″	1882.	s	″
Oct. 13	38·18	159·4	Nov. 6	23·46	59·6
14	37·47	170·5	7	26·11	42·5
15	36 50	180·5	8	28·59	25·1
16	35·27	189·2	9	30·88	− 7·5
17	33·78	196·6	10	+32·98	+ 10·2
18	32·05	202·6	11	34·87	27·6
19	30·09	207·2	12	36·55	44·9
20	27·92	210·3	13	38·00	62·0
21	−25·54	−212·0	14	39·21	78·7
22	22·98	212·1	15	40·18	94·9
23	20·25	210·8	16	40·90	110·6
24	17·37	208·0	17	41·36	125·6
25	14·37	203·7	18	41·58	139·8
26	11·27	197·9	19	41·54	153·1
27	8·08	190·8	20	+41·26	+165·4
28	4·82	182·4	21	40·72	176·9
29	− 1·53	172·7	22	39·94	187·3
30	+ 1·77	161·8	23	38·92	196·5
31	5·06	−149·8	24	37·66	204·5
Nov. 1	8·33	136·7	25	36·18	211·3
2	11·55	122·7	26	34·49	216·8
3	14·69	107·9	27	32·59	221·0
4	17·73	92·4	28	30·50	224·0
5	20·66	76·3	29	28·23	225·6
			Nov. 30	+25·79	+225·8

It would be well to test the correctness of this ephemeris by some early observations of *Iapetus*.

Ephemeris of the Satellite of Neptune, 1882–83.
By A. Marth, Esq.

P, angle of position of the minor axis of the satellite's apparent orbit, in the direction of superior conjunction.

a, *b*, major and minor semi-axis of the apparent orbit.

u—U, longitude of the satellite in its orbit reckoned from the point which is in superior conjunction with the planet, or in opposition to the Earth.

U+180°, planetocentric longitude of the Earth, reckoned in the satellite's orbit from the ascending node on the equator.

B, latitude of the Earth above the plane of the orbit.

0h Gr.	P	*a*	*b*	*u*−U	Diff.	U	B
1882.	°	″	″	°	°	°	°
Aug. 22	317·28	16·52	7·01	301·72	612·59	140·13	25·10
Sept. 1	317·26	16·61	7·04	194·31	·54	140·16	25·10
11	317·20	16·70	7·07	86·85	·48	140·25	25·07
21	317·11	16·78	7·09	339·33	·43	140·38	25·01
Oct. 1	316·99	16·85	7·10	231·76	·38	140·56	24·94
11	316·84	16·90	7·10	124·14	·35	140·78	24·85
21	316·67	16·94	7·09	16·49	·32	141·02	24·74
31	316·49	16·97	7·07	268·81	·30	141·29	24·61
Nov. 10	316·30	16·97	7·03	161·11	·29	141·56	24·48
20	316·12	16·96	6·99	53·40	·29	141·83	24·35
30	315·94	16·93	6·95	305·69	·30	142·09	24·23
Dec. 10	315·78	16·89	6·90	197·99	·33	142·33	24·11
20	315·64	16·83	6·84	90·32	·36	142·53	24·00
30	315·53	16·75	6·79	342·68	·41	142·69	23·91
1883.							
Jan. 9	315·46	16·67	6·74	235·09	·45	142·80	23·85
19	315·42	16·58	6·69	127·54	·40	142·86	23·81
29	315·41	16·48	6·65	20·04	·50	142·87	23·80
Feb. 8	315·44	16·39	6·62	272·60	·62	142·81	23·81
18	315·51	16·30	6·59	165·22	·67	142·71	23·85
28	315·61	16·21	6·57	57·89	612·72	142·55	23·91
Mar. 10	315·75	16·12	6·56	310·61		142·35	24·00

If the values of P, *a*, *b*, and *u*−U are interpolated for the times for which the apparent places of the satellite are required, the position-angle *p* and distances *s* are found by

$$s \sin (P-p) = a \sin (u-U),$$
$$s \cos (P-p) = b \cos (u-U).$$

The satellite moves in the direction of *dec*reasing position-angles, and will be at its greatest elongations ("*nf*" in posit. P+90° and distance *a*, "*sf*" in posit. P−90°) and at its conjunctions ("*sup.*" in posit. P and distance *b*, "*inf.*" in posit. P−180°) at the following hours, Greenwich M. T.:—

"nf." elong.	"sup." conj.	"sp." elong.	"inf." conj.
1882. h	h	h	h
Aug. 21 11·6	Aug. 22 22·8	Aug. 24 10·1	Aug. 25 21·3
27 8·6	28 19·9	30 7·1	31 18·4
Sept. 2 5·7	Sept. 3 16·9	Sept. 5 4·2	Sept. 6 15·4
8 2·7	9 14·0	11 1·2	12 12·5
13 23·8	15 11·0	16 22·3	18 9·6

"nf." elong.	"sup." conj.	"sp." elong.	"inf." conj.
1882. h	h	h	h
Sept. 19 20·8	Sept. 21 8·1	Sept. 22 19·4	Sept. 24 6·6
25 17·9	27 5·2	28 16·4	30 3·7
Oct. 1 15·0	Oct. 3 2·3	Oct. 4 13·5	Oct. 6 0·8
7 12·1	8 23·3	10 10·6	11 21·9
13 9·2	14 20·4	16 7·7	17 19·0
19 6·3	20 17·5	22 4·8	23 16·1
25 3·4	26 14·6	28 1·9	29 13·2
31 0·5	Nov. 1 11·7	Nov. 2 23·0	Nov. 4 10·3
Nov. 5 21·6	7 8·9	8 20·1	10 7·4
11 18·7	13 6·0	14 17·2	16 4·5
17 15·8	19 3·1	20 14·3	22 1·6
23 12·9	25 0·2	26 11·5	27 22·7
29 10·0	30 21·3	Dec. 2 8·6	Dec. 3 19·8
Dec. 5 7·1	Dec. 6 18·4	8 5·7	9 16·9
11 4·2	12 15·5	14 2·8	15 14·0
17 1·3	18 12·6	19 23·9	21 11·1
22 22·4	24 9·7	25 21·0	27 8·2
28 19·5	30 6·8	31 18 1	Jan. 2 5·3
1883.			
Jan. 3 16·6	Jan. 5 3·9	Jan. 6 15·1	8 2·4
9 13·7	11 0·9	12 12·2	13 23·5
15 10·8	16 22·0	18 9·3	19 20·6
21 7·8	22 19·1	24 6·4	25 17·6
27 4·9	28 16·1	30 3·4	31 14·7
Feb. 2 1·9	Feb. 3 13·2	Feb. 5 0·5	Feb. 6 11·7
7 23·0	9 10·2	10 21·5	12 8·8
13 20·0	15 7·4	16 18·5	18 5·8
19 17·0	21 4·3	22 15·6	24 2·8
25 14·1	27 1·3	28 12 6	Mar. 1 23·8
Mar. 3 11·1	Mar. 4 22·3	Mar. 6 9·6	7 20 8

The Solar Eclipse, 1882, *May* 16. By the Rev. S. J. Perry.

With the view of comparing the times of spectroscopic and of ordinary telescopic contact, I arranged to have the partial eclipse of May 16 observed by Mr. W. McKeon with the 8-inch

Equatoreal and a Browning automatic spectroscope of six prisms, and by Mr. J. Rooney with the 9½-inch Cassegrain and an ordinary negative eyepiece. The sky was perfect, and the dispersion used with the spectroscope was that of ten prisms of 60°, the pencil of light passing twice through each of the first five prisms of the instrument. The slit was kept tangent to the limb of the Sun at the calculated point of contact.

At G.M.T. $18^h\ 19^m\ 21^s{\cdot}85$ the Moon was first seen on the upper limit of the chromosphere.

„ „ $18^h\ 19^m\ 38^s{\cdot}00$ the Moon had half covered the chromospheric layer.

„ „ $18^h\ 19^m\ 48^s{\cdot}97$ the Moon reached the base of the chromosphere, and the solar spectrum was darkened at the limb.

With the Cassegrain—

At G.M.T. $18^h\ 19^m\ 36^s{\cdot}00$ the limb of the Sun near the point of contact suddenly became quite steady.

„ „ $18^h\ 19^m\ 56^s{\cdot}50$ a very minute indentation was first observed. Definition excellent.

At the end of the eclipse—

G.M.T. $19^h\ 21^m\ 9^s{\cdot}90$ the chromosphere was first seen at the point of last contact; possibly a second or so late.

„ $19^h\ 21^m\ 20^s{\cdot}50$ the last contact was observed with the Cassegrain. Observation excellent.

The points of the solar limb cut by the Moon were watched very narrowly during the progress of the eclipse, and the chromosphere was always observed to be cut very sharply by the Moon's limb.

The bright chromospheric lines C and F near the lunar edge were seen projected far within the spectrum of the photosphere, and were both widened and curved, the displacement being very marked from the juxtaposition of the dark and bright lines.

The dark atmospheric lines were also observed to be curved in close proximity to the Moon.

Four faint bright lines were traceable between B and C in the solar spectrum.

After the eclipse, the whole chromosphere was measured. The mean height near the point of first contact was found to be $8''{\cdot}54$, with a slight prominence, whose maximum height was

22″·64, at 2° distance. The mean height of the chromosphere near the point of last contact was 10″·68, prominences being at 2° and 1° 30′ on either side, whose maximum heights were 33″·32 and 45″·28 respectively.

The director of the Lyons Observatory, M. Ch. André, has kindly sent me an account of his observations during the same eclipse; and I venture, with his permission, to extract a few lines from his letter, as they are of considerable interest at the present moment.

"Une observation, que nous venons de faire lors de l'éclipse partielle du 16 mai 1882, vient à l'appui de ces mêmes idées [explanation of the phenomena of the black drop by M. André]. Si l'on cherche à observer l'éclipse d'une tâche solaire par la lune en notant par exemple le contact d'un des bords de la tâche avec le bord de l'échancrure solaire, on observe constamment un ligament noir analogue à celui du passage de *Vénus* ou de *Mercure*. Après reflexion, ce fait, qui m'avait d'abord surpris, est très simple. Le phénomène en question est un effet du même ordre que celui du passage de *Vénus* : il en diffère en ce que

"1° L'obscurité de la tâche est moindre que celle de *Vénus*.

"2° Le corps obscur est fixe et le corps lumineux mobile.

"3° Les deux corps qui arrivent au contact tournent ici leurs courbures en sens inverse.

"Les ligaments ne sont donc point, comme quelques astronomes le croient, des apparences spéciales aux passages des planètes sur le soleil. Ce sont bien certainement des phénomènes de diffraction dus à l'appareil optique qui sert aux observations ; on doit les traiter comme tels."

Another remark in the same letter also bears upon this subject. "L'observation du passage de *Mercure* à Ogden du 4 mai 1878 a complètement verifié toutes les conséquences que j'avais déduites de mes expériences."

Stonyhurst Observatory:
1882, *June* 6.

Further Spectroscopic Observations of Comet a, 1882 (*Wells*), *made at the Royal Observatory, Greenwich.*

(*Communicated by the Astronomer Royal.*)

The spectrum of this interesting object has been observed on four occasions since the date of the first Note—viz. on May 13, May 20, May 31, and June 7. The most striking feature which it has exhibited has been the remarkable development of a bright line in the yellow, apparently coincident with the D lines of sodium.

This line was first remarked on May 31, when two measures of its position were obtained with the single-prism spectroscope. These gave its wave-length as 5902·5 and 5903·0 tenth-metres, or 10·5 and 11·0 tenth-metres from D towards the red. The measures were made with great difficulty, owing to the exceed-

ingly awkward position of the spectroscope, and are hence very rough. The bright line seemed two or three times as bright as the continuous spectrum on which it appeared.

Another view of the comet was secured early in the morning of June 8 (at about June 7, $15^h\ 40^m$), when the bright line had become of the most extraordinary brilliancy, and so far outshone the continuous spectrum that the comet might almost be said to shine by monochromatic light. The telescopic appearance of the comet was in strict accordance with this view, as it showed a distinct planetary disk of an orange color, nearly as deep and vivid as that of *Mars*. The comet was seen in the finder till $15^h\ 50^m$, 4^m after sunrise. Only one measure could be obtained of the position of the line, and this measure was unfortunately rendered very rough from the difficulties of the comet's position, &c. The resulting wave-length was 5894·5 tenth-metres, assuming 5892·0 as the wave-length of the D lines. The displacement, which was towards the red, would indicate a motion of recession of 79 miles per second. The "Half-prism" spectroscope, with one half-prism, in the direct position, as used for measures of displacement of the lines in stellar spectra, was employed; magnifying power 14°, dispersion 18½° from A to H.

Besides this remarkable bright line, several trifling irregularities in the continuous spectrum were seen or suspected on different occasions.

On April 24, as stated in the former Note, two ill-defined maxima were remarked in the green and greenish-blue.

On May 13 one such ill-defined maximum was suspected near E, a little to the red of the sharp edge of the green band obtained from a Bunsen-flame.

On May 20 the spectrum presented much the same appearance, except that the fainter districts bounding the two maxima above mentioned rather attracted attention and three minima were observed instead of two maxima. These minima, or faint dark bands, seemed fairly sharp at the edges. Three measures were obtained of the most distinct, which was, however, an exceedingly difficult object. These gave its wave-length as 4818, 4811, and 4855 tenth-metres respectively. The middle dark band was measured as about 5500 tenth-metres. No measures could be obtained of the third dark band, which was near D but on the blue side of it.

The spectrum of the nucleus extended from about λ 4300 to λ 6150. The spectrum of the tail was also continuous, but visible only in the green. It might be mistaken for the green band of the Bunsen-flame, but seemed too regular and to extend too far towards the red.

On May 31 the spectrum presented a very similar appearance to that shown on May 20, but, being much brighter, details were better seen.

Two dark spaces were seen near F; the less refrangible one was measured, and its wave-length determined as 4862 tenth-

metres. It therefore probably is the F line. A bright streak was seen further towards the red; this was measured as 5146 tenth-metres. A second bright streak was measured at 5328 tenth-metres. A dark band about 120 tenth-metres in breadth was seen close to the bright line near D, but nearer the blue.

On May 22 and June 7 none of these minor irregularities in the continuous spectrum were remarked. At best they were exceedingly difficult and ill-defined objects, and would easily be overpowered by the strong twilight in which the comet was observed on those two occasions. The observations were made by Mr. Maunder throughout.

Royal Observatory, Greenwich:
1882, *June* 9.

Postscript.—The comet was seen by Mr. Maunder in full daylight, just after perihelion passage, on June 10, 20^h, with the $12\frac{3}{4}$-inch Equatoreal, using negative eyepieces with powers of 60, 130, 220, and 310. With the lowest power, a light-red glass was necessary, but with the powers 220 and 310 the light of the sky was not too strong for the eye, and the comet could be easily seen as a dull yellow stellar point of light, the disk being no larger than that of a star. It was judged to be not so bright as *Capella*, which had been seen previously, making every allowance for the much brighter background on which the comet was seen. On putting in the transit-micrometer (which has a much larger field) to determine its place, the comet was lost, after having been seen distinctly for a quarter of an hour, and it was not picked up again afterwards. A white haze had gradually formed round the Sun, and the sky became overcast about noon.

On the Spectrum of Comet Wells. By M. N. C. Dunér.

(*Communicated by W. Huggins, Esq.*)

On the evening of June 3 in observing the spectrum of the Comet Wells I remarked in the continuous spectrum of the nucleus a considerably bright dot, which by reducing the breadth of the slit turned out to be a narrow line. The following measurements of the wave-length show that the line was due to the presence of sodium :—

λ
5897
5895
5894

The first set is much less accurate than the two others, being determined with a less powerful ocular.

The bright line was not limited to the spectrum of the nucleus,

but extended itself, though considerably fainter, far into the coma.

The observation was made with the Refractor of the Observatory at Lund (aperture 245 millimètres) and a universal spectroscope by Merz with one direct vision prism.

Lund: 1882, *June* 5.

Elements of Comet Wells, obtained graphically.
By F. C. Penrose, Esq.

T, very roughly computed				June 10·0
$\pi - \Omega$	...	...	...	209° 0′
Ω	...	...	...	205 30
i	...	...	...	74 22
D or q	...	...	...	[8·77815]

Observations of Comet b, 1881. By T. W. Backhouse, Esq.

The accompanying table gives the brightness of the head of this comet—*i.e.* the nucleus with its surrounding nebulosity; the length and greatest width of the tail, as measured on Proctor's map from my drawings and notes of its position; and the direction of the tail—*i.e.* of the middle when it was of uniform brightness, or of the brightest line when one part was decidedly brighter than the rest of the width. The next column gives the part to which the observation of its direction refers. The last column but one gives the mode of observation: n. e. indicating the naked eye; specs., spectacles to correct my short sight; (3·5), a pair of field-glasses, power 3·5, aperture 1½ in.; (5) and (2·2), single field-glasses of these respective powers; and (20) and (38), these powers of my Cooke's 4¼-in. Refractor. The last column gives the hindrances to a perfect view. There was more or less twilight in all the earlier observations, if not up to August 3; though at midnight on July 2, 3, and 4, and from July 22, it was almost imperceptible at the comet's position.

The comet was quite white. This circumstance I noted from June 29 to July 14.

Observations of Comet b, 1881.

Place and Time.	Brightness of Head.	Length of Tail.	Max. Width of Tail.	At Distance from Nucleus.	Central or Brightest Line of Tail: passes or points to	Central or Brightest Line of Tail: at distance from nucleus.	Modes of Observation.	Hindrances.
		°	°	°		°		
Tyndrum, Perthshire.								
h m June 29, 13 18	—	$3\frac{1}{2}$	$\frac{3}{5}$		About Polaris		(3·5)	Twilight
,,	= α Urs. Maj.*; considerably fainter than Polaris †	Abt. 4 §			—		n. e.	,,
13 29	—	Abt. $5\frac{1}{2}$ §			—		,,	,,
Sunderland.								
July 1, 11 32	—	$7\frac{1}{2}$			$\frac{2}{5}$ (α, δ) Urs. Min.		,,	,,
11 50	—	13			$\frac{1}{3}$ (δ, ε) ,,		,,	,,
12 20	—	$14\frac{1}{2}$			δ Urs. Min. $\frac{1}{4}$ (δ, ε) Urs. Min.	3 $14\frac{1}{2}$	,,	,,
12 40	Between ε* and ζ* Urs. Maj.; brighter than α*; brighter than γ Cass.*		$1\frac{3}{4}$	10	—		,,	,,
Newhaven, Sussex.								
July 2, 11 5	= ε Urs. Maj.*; brighter than α Urs. Maj.	$17\frac{1}{2}$	$2\frac{1}{2}$	12	$\frac{2}{3}$ (α, δ) Urs. Min. $\frac{1}{3}$ (δ, ε) ,,	for first 3° 4° to $17\frac{1}{2}$°	,,	,, Not very clear
Abt. 12 30	—	$20\frac{1}{2}$	$4\frac{1}{4}$	18	M. Cam. Slightly *f* P VI. 292 $\frac{2}{5}$? (P XII. 232, δ Urs. Min.	5 $10\frac{1}{2}$ 20	,,	,,

Place and Time.	Brightness of Head.	Length of Tail.	Max. Width of Tail.	At Distance from Nucleus.	Central or Brightest Line of Tail: passes or points to	Central or Brightest Line of Tail: at distance from nucleus.	Modes of Observation.	Hindrances.
Newhaven, Sussex.		°	°	°				
July 3, 10 5	—				M. Cam.	$3\frac{1}{2}$°	„	Twilight
10 25	—	$12\frac{1}{2}$	$1\frac{1}{4}$	8	$\frac{2}{5}$ (δ, ϵ) Urs. Min.	lower part		
					$\frac{2}{3}$ (δ, ϵ) „	most of tail	„	„
11 20	—				Slightly *p* M Cam.	up to $1\frac{3}{4}$°		
					M. Cam.	$3\frac{1}{2}$	(5)	„
12 10	—	17	$3\frac{3}{4}$	$12\frac{1}{4}$	P VI. 292	9		
					$\frac{3}{7}$ (α Urs. Min., P XII. 232)	16	n. e.	„
12 15	= α Urs. Min. *; = η Urs. Maj. *				—		„	„
4, 12 5	—	16	$4\frac{1}{3}$	11	P VI. 292, or perhaps a little *f* it	8		
					$\frac{5}{9}$ (α Urs. Min., P XII. 232)	15	„	„
13 0	Scarcely fainter than α Urs. Min. *; = ζ Urs. Maj. *				—		„	„
Darlington.								
July 7, 10 10	Far fainter than α Urs. Min.				—		„	„
10 50	Much fainter than ζ Urs. Maj.				—		„	„
10 50	—	Abt. 3			—		„	„
12 0	Between α and γ Urs. Maj.?	$8\frac{1}{4}$	1·4	7	—		(2·2)	„
North Berwick.							n. e.	„
July 14, 11 50	Rather brighter than κ Draconis				—		„	„
11 55	—				The star at R.A. 155° N.D. 83°	$1\frac{3}{4}$	(2·2)	„

Place and Time.	Brightness of Head.	Length of Tail.	Max. Width of Tail.	At Distance from Nucleus.	Central or Brightest Line of Tail: passes or points to	Central or Brightest Line of Tail: at distance from nucleus.	Modes of Observation.	Hindrances.
North Berwick.								
July 14, 11 55	—	$7\frac{1}{2}^\circ$	$\frac{6}{7}^\circ$	$6\frac{1}{2}^\circ$	$\frac{2}{5}$ (ϵ, ζ) Urs. Min.	7°	n. e.	Twilight
12 15	= ϵ Cass.	$8\frac{1}{2}^\circ$			—		,,	,, Perhaps moonlight
Sunderland.								
July 20, 11 4	= κ Drac.				—		,,	Twilight
12 5	Rather brighter than κ Drac.; about half way from ϵ Cass. to ζ Urs. Min.* in brightness	11°	3°	11°	$\frac{2}{5}$ (ϵ, ζ) Urs. Min. $\frac{3}{5}$ (ϵ, ζ) ,,	4° 11°	,,	,,
22, 12 0		$9\frac{1}{2}^\circ$			$\frac{1}{2}$ (ϵ, ζ) Urs. Min.		,,	Very little twilight
27, 10 15	Considerably fainter than κ Drac.; scarcely brighter than δ Urs. Min.; rather brighter than ϵ				—		,,	Twilight
12 15	Rather brighter than δ Urs. Min.; slightly brighter than λ Drac.; considerably fainter than κ; $\frac{2}{3}$ from κ Drac. to δ Urs. Min. in brightness	$9\frac{1}{2}^\circ$	2°	$7\frac{1}{2}^\circ$	ζ Urs. Min.	$9\frac{1}{2}^\circ$	,,	
29, 12 0	—	$8\frac{1}{2}^\circ$	1°	Abt. $3\frac{1}{2}^\circ$	$\frac{1}{3}$ (ζ, ϵ) Urs. Min. ζ, or $\frac{1}{2}^\circ$ n of it	2° $8\frac{1}{2}^\circ$	,,	Not very clear
31, 12 37	—	8°	$1\frac{1}{4}^\circ$	$3\frac{2}{3}^\circ$	$\frac{3}{5}$ or $\frac{2}{3}$ (ϵ, ζ) Urs. Min. $\frac{11}{12}$ (ϵ, ζ) ,,	2° 8°	specs.	
12 45	Slightly brighter than 5 or ϵ Urs. Min.; rather fainter than δ				—		n. e.	

Place and Time.	Brightness of Head.	Length of Tail.	Max. Width of Tail.	At Distance from Nucleus.	Central or Brightest Line of Tail: passes or points to	Central or Brightest Line of Tail: at distance from nucleus.	Modes of Observation.	Hindrances.
		°	°	°		°		
Sunderland.								
Aug. 1, 10 42	—				$\frac{2}{3}$ (ε, ζ) Urs. Min.	2	(3·5)	Not so clear as lastnight
12 10	—	$7\frac{1}{2}$			ζ Urs. Min.	$7\frac{1}{2}$	n. e.	
3, 11 20	—				$\frac{3}{4}$ (ε, ζ) Urs. Min.	$1\frac{3}{4}$	(3·5)	Hazy
4, 12 3	—	$6\frac{1}{2}$	$1\frac{3}{4}$	5	ζ Urs. Min.	$6\frac{1}{2}$	n. e.	
12 10	Scarcely = 4 Urs. Min., but considerably brighter than 5				—		„	
12 30	—				Much to *n.* of ζ Urs. Min.		(3·5)	
12 50	= about Comet *c* ‡				—		n. e.	Twilight
5, 12 25	—	$6\frac{1}{4}$			ζ Urs. Min.		„	Not very clear
10, 10 45	Invisible				—		n. e. & specs.	Moonlight
10 45	—	$1\frac{1}{7}$			—		(3·5)	„
14, 10 40	Far fainter than the star at R.A. 205°, N.D. 78½°	$2\frac{1}{2}$			ζ Urs. Min.		„	„
18, 10 10	—	1			—		n. e.	Slight light from town
10 15	—	$3\frac{3}{4}$	1	Abt. $2\frac{3}{4}$	Slightly *s.* of θ Urs. Min.	$3\frac{3}{4}$	(3·5)	Less light if any
12 10	—	$3\frac{3}{4}$			θ Urs. Min.	$3\frac{3}{4}$	„	Moonlight

Place and Time.	Brightness of Head.	Length of Tail.	Max. Width of Tail.	At Distance from Nucleus.	Central or Brightest Line of Tail: passes or points to	Central or Brightest Line of Tail: at distance from nucleus.	Modes of Observation.	Hindrances.
Sunderland.		°	°	°		°		
Aug. 25, 10 30	Slightly brighter than P XIV. 273	$2\frac{1}{3}$	Broad		—		(3·5)	
Sept. 7, 10 5	—	40′			—		(20)	Full moon
14, 11 15	—	25′	Abt. 8′		About 5° *s.* of *f*		(20)	Moonlight
11 30	Considerably fainter than 20 Urs. Min.	None			—		(3·5)	,,
11 30	Invisible				—		n. e.	,,
12 5	—	28′			—		(38)	,,
16, 10 45	—	40′	Abt. 11′		About 7° *s.* of *f*		(20)	
11 0	Invisible				—		n. e.	
11 0	—	30′			—		(3·5)	
19, 8 20	Invisible				—		n. e.	
8 20	Considerably fainter than 20 Urs. Min., or than the star at R.A. 244°, N. D. $73\frac{30}{4}$°	10′			—		(3·5)	
8 50	—	35′	22′		5° or 10° *s.* of *f* 15° or 20° *s.* of *f*	10′ 35′	(20)	
Scarborough.								
Sept. 26, 10 10	Visible, together with a much fainter star near				—		n. e.	

* Means that the object, compared with Comet *b*, was more favourably situated; † much more so; ‡ less so.

§ Estimated; no stars to compare it with.

Remarks on the Tail.

June 29.—Curvature suspected. (3·5.)

July 1.—Probably curved, in lower part. (Naked eye.)

July 2, 11^h 5^m.—Slightly curved. For the first 3° the middle of the tail points to $\frac{2}{3}$ (α, δ) *Ursæ Minoris*; but this is not the brightest line, for the *p* side is slightly the brightest part in the lower portion of the comet. (Naked eye.)

12^h 30^m.—The tail has a slight appearance of bifurcation, because above this lower portion the *p* side is exceeded in brightness by the continuation of the *f* side,* which, however, ceases to be the side, since much fainter light appears on its left. The tail then becomes much more indefinite, curving considerably to the left. It is doubtful from my notes whether it passed $\frac{2}{5}$ or $\frac{3}{5}$ from P XII. 232 to δ *Urs. Min.*, but the former appears to have been correct. (Naked eye.)

July 3, 11.20.—The *p* edge much better defined than the *f* edge. This superior definition begins to be perceptible rather more than 1° from the nucleus, and increases beyond M *Cam.* (5.)

12.10.—With the exception of the first degree or two from the head, the main part of the tail is quite straight; but the appearance of curvature is produced by the diffused *f* part of the tail becoming brighter relative to the rest as it recedes from the nucleus. This diffused part causes the *f* edge of the tail to be worse defined than the *p* throughout, except at the beginning and end. (Naked eye.)

July 4, 11.42.—At 6° from the nucleus the tail is as bright as the brightest parts of the Milky Way in *Cygnus*, which are in rather darker sky. (Naked eye.)

12.5.—The *p* side the brightest from M *Cam.* to a distance of 10° from the nucleus. Curvature of lower part of tail very slight indeed. The diffused *f* part of the tail brighter relatively than on the 3rd. The *p* and *f* sides of the tail are so different that, whereas the *p* side seems an emanation from the head, the *f* side seems rather an emanation from the *p* side. (Naked eye.)

July 14, 11.55.—Tail slightly curved.

July 20, 12.5.—Tail straight, but in the lower part the brightest line is nearer the *n* than the *s* edge. (Naked eye.)

July 27, 12.15.—Ditto. ζ *Urs. Min.* is at the end of the tail, the *s* edge ending a little *s* of it; the *n* edge does not reach so far, pointing to $\frac{4}{7}$ (ϵ, ζ). The whole tail faint, except close to the nucleus. (Naked eye.)

July 31, 12.37.—The end of the tail is a prolongation of the *s* side of the earlier part, but is slightly curved, concave to *s*. (Naked eye.)

Aug. 4, 12.3.—Straight. The *s* edge extends furthest. (Specs.)

* M *Cam.* is in the brightest line of this, and P VI. 292 slightly precedes it.

12.30.—Brightest line in lower part of tail is near the *n* edge. (3·5.)

Aug. 14, 10.40.—North edge most definite. (3·5.)

Aug. 18, 10.15.— „ „ „ North edge points to, and ends, slightly *s* of *θ Urs. Min.*; *s* edge points to nearly half way from *ζ* to *β*. (3·5.)

12.10.—North edge ends slightly *n* of *θ Urs. Min.* (3·5.)

Telescopic Notes.

July 1, 12.25.—Sides slightly brighter than middle (20). Width about 17′ at 47′ off nucleus.

July 20, 12.45.—Width of tail about 36′ at 1° 40′ off the nucleus. The *p* edge much more definite than the other. (20.)

July 27, 10·37.—Radius of that half of coma away from the tail, $5\frac{1}{2}'$. (38.)

July 29, 11.2.—It is 6′·3. (38.)

July 30, 12.0.—It is $7\frac{1}{2}'$ or 8′. The *n* side of the tail much the brighter. (38.)

Sept. 14, 11.15.—Diameter of head 8′. (20.)

Sept. 16, 10.45.— „ „ $7\frac{1}{2}'$. (20.)

Sept. 19, 8.50.— „ „ 15′. (20.)

From Oct. 30 to Nov. 24 I frequently observed the comet at Sunderland with the telescope (chiefly powers 38 and 20), and found it very faint, but rather large; generally 6′ to 8′ in diameter. But there seemed frequently to be a still greater, though very feeble, extension in one direction, or sometimes in more than one; making its longest diameter once as much as 12′. But, as these extensions did not always appear in the same direction, it occurred to me whether they were not merely an illusion, perhaps caused by the neighbourhood of small stars to the comet. At the same time, I could not make out that this was the case. Perhaps the continued large size of the comet was illusory also. With higher powers it looked much smaller; but this is no proof that the larger size with low powers was unreal.

Shortly after the last date mentioned above, the comet ceased to be visible in my telescope.

Spectroscopic Notes.

July 1, $12^h\ 45^m$ to $13^h\ 15^m$.—With a Browning's miniature spectroscope on the $4\frac{1}{4}$-in. Refractor, the nucleus has a bright continuous spectrum, with bright bands upon it; the continuous spectrum, however, being the more conspicuous part. The three usual bright cometary bands are conspicuous, and there is a much fainter one, not very easily seen, about as far off the most refrangible of the three as that is off the middle (brightest) one. I believe there is another near it, and that there are irregularities between them and the other bright bands. In the coma there are only the three usual bright bands, and they are much more conspicuous than its continuous spectrum.

July 4.—With a prism of Chance's dense flint glass, and no slit or any other instrument, the most conspicuous part of the spectrum is the two less refrangible bright bands (or rather points, as they appear when so observed) in the spectrum of the head. The continuous spectrum of the nucleus is also plain; and the third band, though it is much fainter than the least refrangible one. The middle band much the brightest. With two prisms the spectrum is still plainer; but I can see no other band. As to the tail, I could not be sure that its spectrum was otherwise than simply continuous.

July 22, 11.55.—With the miniature spectroscope on the telescope, the three bright bands are still very conspicuous in the spectrum of both nucleus and coma, especially the latter; the fourth band very faintly visible in that of the nucleus only. The brightest band is visible to a distance of at least 4′ or 5′ preceding the nucleus, and the two other bright ones nearly as far; while *f* the nucleus—*i.e.* along the tail (though this direction is not along its axis)—these are visible to a distance of $4\frac{1}{2}'$, and the brightest band to 8′.

Aug. 4.—The three bright bands still conspicuous. The continuous spectrum relatively much fainter than before. The fourth band invisible.

Sept. 16.—The brightest band conspicuous, and the least refrangible one plain, but the third (the most refrangible) scarcely visible. There is also a faint continuous spectrum, but no trace of the conspicuous bright longitudinal line that formed the continuous spectrum of the nucleus in the early part of this comet's appearance.

This is the only comet in which I have certainly seen the fourth bright band, though I suspected one about the same place in the great comet of 1874 and in Comet *a*, 1882. I did not measure its position, but if the above estimate is correct, it must be rather less refrangible than the violet carbon band—say about wave-length 436; the bands I suspected in the comets of 1874 and 1882 seemed even less refracted: it is therefore improbable that I can have seen any of the bands photographed by Dr. Huggins.

Sunderland:
1882, *June* 5.

Sextant Observations of Comet b, 1881. By Capt. J. F. Parson.

(*Communicated by Captain H. Toynbee, R.N.*)

	G. M. T. d h m s
1881, June 24, in about $44\frac{1}{2}°$ N. 9° W.	23 13 48 00

	° ′
Angular distance from Pole Star	43 41
„ „ *Capella*	4 43

		G. M. T. d h m s
June 25, in about 41½° N. 12° W.		25 10 4 30
Angular distance from Pole Star	36° 3′	
„ „ *β Ursæ Majoris*	42 13	
June 29, in about 30° 20′ N. 20′ W.		29 11 6 00
Angular distance from Pole Star	23 47	
„ „ *α Ursæ Majoris*	29 56	
Tail increasing in length since last seen.		
July 3, in about 21° N. 25° W.		3 10 3 00
Angular distance from Pole Star	15 20 *	
„ „ *α Ursæ Majoris*	24 50 *	

On the possible Existence of Perturbations in Cometic Orbits during the Formation of Nuclear Jets; with Suggestions for their Detection. By C. E. Burton, Esq.

The sudden and extensive changes which took place in the nuclear jets of Comet *b*, 1881, together with the great brilliancy of some of these streams in the neighbourhood of the nucleus, suggested and appeared to justify the conclusion that if the apparent emission of matter from the nucleus or its immediate neighbourhood really took place under the influence of transformed solar radiant energy, there must be corresponding deviations from the original path of the nucleus, measuring the force so brought into action. The visibility of these perturbations will evidently depend, as far as we are concerned, (1) on the distance of the comet from the Earth; (2) on the force by which the matter of the jet is thrown off; (3) on the ratio of the mass thrown off at any instant to that of the nucleus; (4) on the inclination of the direction of the jet to the orbit and to the line of sight, as well as on the angle between the line of sight and the orbit; (5) on the duration of the jet as compared with that of the series of observations. It seems probable that disturbances normal to the orbit would be easier to detect than retardation or acceleration of orbital velocity.

At the discovery of Comet Wells, and for some little time afterwards, it seemed probable that there would be opportunities of testing the suggestions contained in this note, and it is possible that such may yet occur.

The data for an investigation of the probable magnitude of the disturbing effects which form the subject of this note can hardly be said to exist at present, but it seems not unlikely that displacements amounting to several seconds of arc may take place in the course of 24 hours, and that some of the discordance between the computed and observed places are due mainly to the cause now suggested. It is of course difficult to make use of meridian observations, even at the same station and by the

* Distances only approximate: Moon too bright to get good observations.

same observer, when a matter of this kind is under investigation, the time interval between successive observations being far too great; and if observations at different stations separated by sufficiently short arcs are combined, the difficulty of making proper allowance for variations of personal and instrumental equation comparable in magnitude with the quantities sought becomes insuperable.

For this reason it would seem that the work required could best be accomplished by a single observer with the aid of a heliometer, the nucleus of a suitable comet being referred to at least two stars in the neighbourhood of its path at short intervals —*e.g.* half-hourly—for several hours together. The same stars should be employed during the entirety of a series of observations, so that the places of the nucleus concluded therefrom may be affected by a *constant* error, as far as the points of reference are concerned. It will obviously be advisable to make the intervals of observation as nearly equal as possible, to diminish the risk in after-interpolation if it should be decided to treat the observations by the method of differences. Any *per saltum* change in the path of the nucleus thus detected would—especially if coincident with the appearance of a jet—be open to suspicion as being due to the suggested cause, or at least as belonging to a different class from gravitational disturbances.

Loughlinstown, Co. Dublin:
1882, *June* 6.

Note on Lunar Photographs taken after Enlargement of the Primary Image by an Eyepiece. By C. E. Burton, Esq.

Having found by experiments made* with rapid commercial gelatino-bromide dry plates that a dense image was produced by exposure to *direct* moonlight for 4 seconds, and that a dense image of the moon itself resulted in the same time, after the enlargement of the image formed by a small object-glass to the extent of 8 diameters, I requested and obtained the kindly-accorded permission of Dr. Wentworth Erck to make use of his $7\frac{1}{2}$-in. Alvan Clark Equatoreal for further experiments. After some preliminary trials the difference between the focus of the most active photographic rays and the best visual focus was determined by the spectroscope in the usual manner, but after the insertion of a Kellner eyepiece and for the conjugate focus of the latter. The equivalent focal length of the Kellner was about 1 in. and the enlargement of the primary image was 6 diameters. Under these conditions it was found that to bring the yellow rays to a focus after having set to the best focus for the rays in the neighbourhood of F, the eye-tube had to be pushed in 0·10 in. or 0·11 in. Images of printing density were obtained on May 29 and May 31 in 10 and 12 seconds, though the Moon was low, and at the last date the east wind had brought reddish

* 1882, May 27, $11^h\ 30^m$ Dublin M.T.

haze with it, increasing the time necessary for exposure. The slow motion in R. A. was used on May 31 to counteract the Moon's proper motion. The image was sharp but not steady, and the photographs lack sharpness, though they justify expectations of success under more favourable conditions. A faint image of *Mizar* (both components) was obtained in 10 seconds $\pm$ 1 sec., the separation of the two images being very satisfactory (0·10 in.) and = 3 times the diameter of the denser. Ferrous oxalate was employed for development.

Previous trials* had been made with a 9-in. reflector on an altazimuth mounting, but the difficulty of following was found to be too great under the then existing circumstances, though it is anticipated that it may be overcome during the short exposures now required.

Loughlinstown:
1882, *June* 5.

Transits of Red Spot across the Apparent Central Meridian of Jupiter, with the Corresponding Longitudes, according to the System of Longitudes of Mr. A. Marth (Monthly Notices, vol. xli. No. 7), the Times reduced to the Meridian of Greenwich. Observed at Morrison Observatory, Glasgow, Missouri. By Professor C. W. Pritchett.

Date.	Prec. End.	Middle.	Foll. End.	Wt.	Long. Prec. End.	Long. Middle.	Long Foll. End.
	h m	h m	h m		°	°	°
1881, July 4		22 16·4	22 47·9	4		5·9	24·9
11	22 32·6	23 4·6		3	347·9	7·2	
16	21 40·3	22 12·8	22 44·2	4	347·9	7·5	26·5
23	22 23·8	22 56·3	23 28·3	4	346·5	6·2	25·5
28		22 6·3	22 37·8	4		7·7	26·8
Aug. 9	21 24·6	21 57·0	22 28·5	4·5	347·0	6·6	28·4
21			22 25·1	3·5			28·3
28	22 7·8	22 40·8	23 11·3	4	351·0	11·0	29·4
Sept. 4	22 51·1	23 24·1	23 54·3	3	350·3	10·3	28·5
11	23 33·8	0 7·8		3	349·4	9·9	
19		20 47·3	21 17·3	3·5		12·6	30·8
20		16 39·3	17 9·3	3·5		13·2	31·4
Oct. 4	17 26·8	17 59·0	18 30·3	3	349·3	10·9	28·0
7		15 34·3		3		12·8	
9	16 38·7	17 10·7	17 40·8	3	352·7	12 8	30·2
14		16 18·4		3		13·1	
19	14 53·9	15 25·5	15 53·8	5	354·8	13·8	31·0
31	14 39·8	15 12·8		3	352·9	12·7	

* 1882, April 25, 8^h+, D.M.T. Dense impression with 15^s exposure to an image magnified about 7 diameters.

Date.	Prec. End.	Middle.	Foll. End.	Wt.	Long. Prec. End.	Long. Middle.	Long Foll. End.
	h m	h m	h m		°	°	°
1881, Nov. 5	13 50·3	14 21·8	14 48·8	3	355·8	14·8	31·2
12	14 34·3	15 5·3	15 36·3	2·5	356·3	15·5	33·8
14	16 12·0	16 40·3	17 10·3	3	356·5	13·6	31·7
19	15 18·1	15 49·8		3	356·6	15·8	
24	14 24·3	14 56·3	15 27·3	3·5	356·8	16·1	34·9
26	16 2·5	16 33·6		3	357·2	16·0	
Dec. 1	15 9·8	15 41·3	16 9·8	3·5	357·8	16·9	34·1
6	14 18·3	14 49·3	15 20·0	3·5	359·2	17·9	36·5
15	16 44·3	17 14·3	17 43·3	3·5	1·5	19·7	37·1
23	13 18·3	13 48·3	14 18 3	5	0·5	18·6	36·8
25		15 27·3	15 56·8	5		19·6	36·9
1882, Jan. 6	14 50 3	15 18·8	15 48·3	3	1·4	18·7	36·6
11		14 37·8		3			38·3
13	15 38·3	16 6·3		2·5	2·8	19·7	
Feb. 2		13 10·5		4			39·3
4		14 19·3	14 48·8	2·5		21·2	40·3
9		13 33·3	14 1·3	3		24·8	41·7

Observations of the Phenomena of Jupiter's Satellites, made at Mr. Edward Crossley's Observatory, Bermerside, Halifax. By J. Gledhill, Esq.

Date. 1881.	Satellite and Phenomena.	G.M.T.	*Naut. Alm.*	Remarks.
		h m s	h m s	
Oct. 3	II. Ec. D. Fading away?	10 52 0	10 55 7	Sky not good.
	Certainly fading	53 0		
	Still visible	56 0		
	Gone	56 30		
12	II. Tr. I. First contact	9 16 0	9 15 0	Very bad definition.
	Inner contact	9 18 0		
14	I. Sh. I. Just on disk	10 45 0	10 42 0	Bad sky.
	I. Tr. I. Outer contact	11 25 0	11 26 0	„
	Inner „	11 28 0		„
Nov. 20	II. Tr. I. First contact	9 40 0	9 42 0	Fair.
	Bisection	9 43 0		
	Inner contact	9 44 0		Good.
	II. Sh. I. First seen	10 4 0	10 4 0	Windy; clouds.
	Inner contact	10 7 0		
22	II. Ec. R. First seen	7 32 49	7 33 41	
	Full?	7 36 15		

Date.	Satellite and Phenomena.	G.M.T.	*Naut. Alm.*	Remarks.
1881.		h m s	h m s	
Nov. 22	I. Tr. I. Outer contact	8 55 0	8 55 0	
	Bisection	58 0		
	Inner contact	59 0		
	I. Sh. I. First seen	9 9 44	9 10 0	
	Inner contact	9 12 0		
	I. Tr. E. Outer contact	11 8 0	11 7 0	
	I. Sh. E. Just off	11 23 0	11 22 0	Uncertain.
25	III. Sh. I. Just within	11 11 0		Much motion.
	III. Tr. E. Outer contact	11 26 0	11 26 0	Rough observation.
29	II. Oc. D. Outer contact	6 45 0	6 45 0	
	Inner „	6 49 0		
	II. Ec. R. First seen	10 8 10	10 9 1	
	Full disk	10 10 30		
	I. Tr. I. First contact	10 40 0	10 39 0	
	Bisection	42 0		
	Inner contact	44 0		
	I. Sh. I. Inner contact	11 6 0		Bad sky.
ec. 7	I. Oc. D. First contact	9 32 30	9 35 0	Much motion.
	Bisection	35 0		„
	Second contact	36 30		„
14	I. Oc. D. Last seen	11 21 0	11 21 0	
22	II. Tr. E. Just off	10 40 30	10 43 0	
	I. Sh. I. Bisection	11 18 0		
	Just within	11 19 0		
1882.				
Jan. 24	I. Ec. R. First seen	7 23 21	7 23 33	Good observation.
	Full?	29 0		
Feb. 15	II. Oc. D. First contact	9 29 30	9 29 0	Bad definition.
	Inner contact	9 32 30		„
Mar. 3	I. Tr. E. Inner contact	7 27 0	7 30 0	
	Outer „	7 31 0		
11	I. Ec. R. First seen	7 56 38	7 56 46	Good sky.
	Full?	7 57 49		
18	I. Ec. R. First seen	9 52 50	9 52 26	

Bermerside, Halifax:
1882, *April* 25.